ELEMENTARY SCHOOL TEACHERS’ ATTITUDES TOWARDS TEACHING MATHEMATICS AND THEIR PROFESSIONAL LEARNING GOALS

by

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A thesis submitted in conformity with the requirements for the degree of Master of Arts
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Abstract

This study examined how elementary teachers identified and set specific goals to improve their mathematics teaching using the framework of the Ten Dimensions of Mathematics Education (McDougall, 2004). This qualitative study investigates the beliefs and attitudes of four Grade 6 teachers using data collected from interviews and surveys.

Based on the evidence found in this study, a relationship exists between teachers’ beliefs and attitudes towards teaching mathematics, their professional learning goals, their instructional practices and student achievement. There were three major findings: (1) teachers’ goals were linked to their weakest dimension and were student centered; (2) teachers’ beliefs on constructing knowledge are not aligned with current mathematics education thinking; and (3) professional development, collaboration, and parental involvement also influenced teachers’ goal setting process. Suggestions for teacher professional learning sessions are discussed, including additions to the teacher change model (Ross & Bruce, 2007).
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Chapter One: Introduction

1.1 Introduction

The purpose of this thesis is to investigate how teachers use the Ten Dimensions of Mathematics Education (McDougall, 2004) to set goals for personal growth and improve their teaching. It is hoped that interpreting teachers’ attitudes and practices towards the teaching of mathematics will reveal their strength and weaknesses in different areas, which will allow them to set specific and attainable goals for improvement. Analyzing how teachers create their goals and the other influencing factors that affect this formation will provide a better understanding on teachers’ primary student needs. Understanding teacher goals is crucial, as they will be reflected in teachers’ practices in the classroom, which will inevitably affect and shape student learning. The ways in which teachers set goals and develop professionally impacts student success.

In this chapter, the research context and questions are defined. My personal interest in this topic, the significance of the study, and the layout of this thesis are also described.

1.2 Research Context

Mathematical literacy is essential for students’ future educational success and for their daily lives at home or at work. The Ontario Ministry of Education (2004) wants teachers to focus their attention in helping students have a strong foundation in mathematics in their elementary school years. The Expert Panel on Mathematics in Grades 4 to 6 in Ontario Report (Ministry of Education, 2004) examined the existing research on the teaching of mathematics and outlined what they considered to be the essential ideas to provide effective mathematics instruction and support for students at the
junior level. They suggested that an effective mathematics program is comprised of a balanced program that builds on students’ previous skills learnt in the primary grades. It includes different instructional approaches such as guided, shared and independent, along with different lesson types such as mini-lessons, games, mental math and problem-based lessons.

According to the Expert Panel on Mathematics, teachers’ instructional practices should provide opportunities to help students develop conceptual understanding, provide time for procedural work so students can retain the information recently learnt, and provide rich problem-solving contexts to deepen their mathematics understanding. Arranging students in different group settings so that they can share their ideas and assessing them in a variety of different ways to give students the opportunity to demonstrate their knowledge in ways that suits them best is also part of the balanced approach. Thus, an effective mathematics program encompasses a variety of elements rather than the simple rote application of procedural knowledge. By applying all of these elements from the balanced program, students will acquire a strong foundation in mathematics (Expert Panel, 2004).

Despite the efforts brought forward by the Ministry of Education, mathematics achievement continues to drop in the elementary grades (EQAO, 2014). Over the past five years, the percentage of Grade 3 students at or above the provincial standard in mathematics has decreased from 71% to 67%, worse still the percentage of Grade 6 students decreased by seven percentage points, from 61% to 54% (EQAO, 2014). Lower percentages are meeting the mathematic standard; in 2013-2014 alone, Grade 6 mathematic scores decreased by three percentage points from the previous years.
Another important problem is that over the past five years, the proportion of students improving to meet the standard in Grade 6 has decreased from 26% to 16% (EQAO, 2014). This is rather problematic because students who do not meet the provincial standard in primary or junior grades are much more likely to carry those difficulties into Grade 9.

This decline in mathematics success over the past five years brings to question whether or not the previously mentioned suggestions from The Expert Panel on Mathematics Report (2004) were put into action. One imperative component of the report was the section on support for mathematics education and learning. The expert panel from the Ontario Ministry of Education (2004) stated:

Supporting mathematics education and learning is a shared responsibility that encompasses all members of the educational community, including the Ministry of Education, district school boards, principals, lead teachers, teachers, faculties of education, and parents. All partners play a vital role in ensuring that optimal conditions for learning and the necessary resources and professional development are present at all levels. (p. 45)

Professional development in mathematics education for teachers is crucial as they begin to teach reform mathematics, where students make sense of new mathematical ideas through exploration and real-life applications rather than the textbook-drill practices. The characteristics of effective professional development according to the Ontario Ministry of Education (2004) are:

- Focused on specific goals that are clearly connected to mathematics and mathematics teaching
- Supports the development of teachers’ knowledge of mathematics
- Supports the development of teachers’ knowledge of how children learn mathematics
- Active learning – it gives teachers the opportunity to try new ideas and discuss them
- Includes support from knowledgeable others
- Values teachers as professionals
In 2011, teacher professional learning was reported again as one of the seven foundational principles for improving mathematics in the elementary grades (Ontario Ministry of Education, 2011). In Bruce, Esmonde, Ross, Dookie and Beatty’s (2010) research, teacher professional learning is an ongoing procedure that is situated in classroom practice, and it is constructed from teacher and student experiences through a process of goal setting, practicing, and reflecting. Their findings suggested that professional learning opportunities require time and ongoing support as well as collaborative practices such as co-planning and co-teaching. In addition, the conclusions indicated an indirect but powerful relationship between increasing teacher efficacy and increasing student achievement. Teacher efficacy positively influences teacher goal setting, which can be seen through the use of challenging teaching strategies that benefit students (Bruce et al., 2010).

Although professional development is regarded as one of the important components for student success, it continues to be a work-in-progress. Professional learning was one of the critical issues of practice according to a recent publication by the National Council of Teachers of Mathematics (NCTM); practitioners continue to struggle with professional learning so a set of research-guiding questions was provided for the mathematics education research community to link research and practice (Arbaugh, Herbel-Eisenmann, Ramirez, Knuth, Kranendonk, & Reed Quander, 2010). This study contributes to the research guiding question by NCTM: “Is there a relationship between elementary teachers’ beliefs concerning the nature of mathematics, their teaching of mathematics, and their students’ success in mathematics?” (Arbaugh et al., 2010, p. 19).
Affirming that there exists a relationship, this research focuses on clarifying the relationship that exists amongst them.

The teacher change model developed by Ross and Bruce (2007), that was influenced by social cognitive theory (Bandura, 1997), is the framework for understanding the relationship among teacher beliefs, teacher practice and student achievement. The theory of teacher change is illustrated in Figure 1 and was developed through a case study that assessed how self-assessment tools helped a grade 8 teacher select improvement goals, facilitate communication between his peers and contribute to his self-efficacy beliefs (Ross & Bruce, 2007).

Figure 1. Model of Teacher Change (Ross & Bruce, 2007).

At the center of the model is teacher self-assessment, which incorporates observations of personal instruction regarding student achievement, judgment on how well teaching goals are achieved, and self-reactions on how satisfied teachers are with
their teaching behaviours. These individual practices affect teacher efficacy, which influence goal setting and teacher effort. These processes jointly impact teacher instructional practice resulting in student achievement. In addition, peers and change agents (e.g., university researchers) influence teacher self-assessments, teacher efficacy, and innovative instruction.

The teacher change model can be applied to the mathematics domain to illustrate the relationship between teachers’ mathematics beliefs, their teaching of mathematics and student achievement. This model serves as the framework for this study with teacher efficacy and teacher goal setting playing a vital role.

1.3 Research Questions

In this study, I explored how four Grade 6 teachers use the Ten Dimensions of Mathematics Education to identify and set specific goals to improve their mathematics teaching. This thesis focuses on the following research questions:

- What is the relationship between identifying in which dimensions each teacher scores higher or lower on and the goals they set for themselves and their students?
- How do elementary school teachers’ beliefs and attitudes towards mathematics influence their professional mathematics teaching goals?
- What are some of the possible influences that contribute to how teachers set and identify their mathematics teaching goals?

A multiple instrumental case study on how Grade 6 teachers engaged in professional learning sessions to improve their teaching practices was conducted to answer the research questions.
1.4 Significance of the Study

Some school districts are forming their professional learning sessions in elementary schools on mathematics teaching. The reason for this emphasis is due to the Ontario Ministry of Education’s (2011) request: “Feedback from the field indicated a need for a closer look at and alignment of K–12 mathematics… the time [has] come to pay focused collective attention to mathematics teaching, leading and learning” (p. 2). This study contributes to these requirements by helping teachers become more aligned with current mathematics education thinking. This research uses the Ten Dimensions of Mathematics Education (McDougall, 2004) in order to identify the areas where practitioners feel that they are (a) most successful, and (b) where they continue to struggle, resulting in an opportunity to accurately craft their mathematics teaching goals.

Limited research currently exists on the Ten Dimensions of Mathematics Education and why or how teachers use it. This study explores this domain, focusing on how teachers use the Ten Dimensions to help them create specific teaching goals with the intention of improving their teaching practices, in hope to positively affect student achievement. This study is an important contribution to the existing research on the Ten Dimensions of Mathematics Education because the collective case study explores how teachers’ attitudes and practices change as a result of the professional learning tools that are given to them.

Teachers play an important and active role in students’ lives and their academic career, thus it is imperative to study what aspects of professional development benefits them most, and what is needed in order to improve teachers’ performance and develop
their professional skills. This research is significant for it will help advance knowledge on the teaching and learning of elementary school mathematics.

1.5 Background of the Researcher

My personal interest in this topic derives from my passion of working with academically low-level students and helping them set goals for themselves. As a novice secondary school mathematics teacher, I would like to take all of the adequate steps myself so that I can positively influence and motivate these types of students to be the best that they can be.

I have always been interested in finding new tools for students to be able to measure their own progress. While completing my Bachelor of Education, I conducted an Action Research Project to find a way that would allow students to become self-regulated learners in a mathematics secondary classroom. In my practicum, I collected data by having my students set weekly goals. They then evaluated themselves at the end of the week on individual “Tracking Sheets,” which provided them a sense of accomplishment (Pyper, 2005). The objective of my study was to evaluate the difference between a traditional lecture-based format versus a student-centered format that involves cooperative learning, self and peer assessments and allows the teacher to become a facilitator rather than a lecturer. I found this tool to be successful in enabling students to become more self-sufficient learners and acknowledge their own progress.

My first professional position was as a summer school mathematics teacher in a private school in Toronto. All of the students that I taught were taking mathematics courses for the second time and disliked mathematics as they felt that the material was too challenging. For the intermediate courses, grades nine and ten, I developed my own
lesson plans and activities. All of their assignments and tasks were related to real life applications and to their interests. However, my primary goal for these students was for them to develop self-regulating skills.

These students were very capable of understanding the mathematics concepts, they just lacked motivation to do their homework and practice their skills learnt in class. Every class, I dedicated the first ten minutes in setting goals and doing motivational exercises and ensuring that they were following up with the goals that they had set for themselves in the beginning. Together we worked on different strategies that would work for them in order to achieve the grades that they desired or needed.

While my experiences are with students of the intermediate and senior levels, I see the value of elementary school teachers setting goals for themselves. My past experiences have led me to believe that goal setting is very important in order to achieve any tasks in our lives. I believe that nothing is impossible as long as one creates a proper action plan and sets appropriate goals for themselves. Without specific and clear goals one can lose focus, which leads to procrastination and lack of motivation. Setting goals helps to stay focused on why one has to do certain tasks.

Currently, as I work as an occasional teacher in the elementary school board, I can see the role that teacher goals play on teaching practices, which inevitably impacts student success. I believe that, by analyzing and understanding how other teachers properly set realistic and attainable mathematics teaching goals, I can use the same strategies in my own professional practice to positively affect student achievement.
1.6 Plan of the Thesis

The thesis is organized into five chapters. Chapter one addresses the research context and outlines the research questions. It also provides a background on the researcher as well as the significance of the study.

Chapter two incorporates a literature review of the existing research and findings in this area. Teacher efficacy is thoroughly explained, focusing mainly on how it affects teacher goals. The importance of goal setting and how it can be used to improve teaching practices is also discussed. The Ten Dimensions of Mathematics Education (McDougall, 2004), the primary element used to help teachers choose their professional goals for improving their mathematics teaching, is described. Finally, the influencing factors that help teachers set their goals, such as professional development, collaboration and parental involvement, are explored.

Chapter three describes the methodology used for this study. The rationale for choosing a collective case study is explained. A description of the participants, who were chosen from a larger research project on School Improvement in Mathematics (McDougall et al., 2015), is given. The process of collecting and analyzing the data as well as the ethical considerations for this study are described.

Chapter four presents the collective case study of four teachers. Each participant’s findings are described, including their teaching goals, and their experience with collaboration and parental communication.

Lastly, chapter five links the findings from chapter four to the research questions found in chapter one. Major findings are reported as well as suggestions for future
elementary teacher professional learning sessions and recommendations for further research.
Chapter Two: Literature Review

2.1 Introduction

The objective of this study is to contribute to the existing body of knowledge surrounding the effects of goal setting on the teaching and learning of mathematics. In this chapter, I present a summary of how teacher efficacy affects the goals teachers set for themselves, focusing on both the type of goal and the process involved in determining and achieving this goal. I provide an overview of goal orientation, its connection to the selection of teaching strategies, and the effect it has on students’ mathematics achievement. In addition, I describe three major factors of how teacher efficacy contributes to student achievement. Next, I provide three methods of effective goal setting and explain the Ten Dimensions of Mathematics Education (McDougall, 2004). I describe each of the ten dimensions and how they can be used as a framework to set specific and attainable goals. Finally, I identify and provide an analysis of three influencing factors (professional development, collaboration, and parental involvement) that help identify and construct teachers’ goals.

2.2 Teacher Efficacy and Goal Setting

Self-efficacy is the belief “in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 2). Within the scope of professional self-efficacy lies the specific concept of teacher efficacy that describes a teacher’s belief about their ability to develop courses of action necessary to bring about desired student results (Tschanne-Moran, Woolfolk-Hoy, & Hoy, 1998).

Tschanne-Moran and Woolfolk Hoy (2001) developed a new measure of teacher efficacy, based on Bandura’s scale, called the Ohio State teacher efficacy scale (OSTES),
that was used in their examination of 410 teacher participants in three separate studies. Not surprisingly, it was found that teachers with high efficacy believe that they can directly influence student learning in a positive way. They also were found to have high expectations for their students and have positive attitudes towards teaching. Conversely, teachers with low teacher efficacy have low expectations for students and believe they are limited in relation to the extent to which they can influence student learning.

However, the benefits of teacher efficacy are confined to student learning. In a quantitative empirical research study of 301 elementary teachers, Haciomeroglu (2013) found that teachers with a strong sense of efficacy towards the teaching of mathematics experience low levels of mathematics anxiety, which contributed to a high degree of confidence in their own skills and abilities to be an effective teacher. In addition, the stronger the sense of teacher efficacy, the more inclined the teacher is in having an “internal locus of control,” where teachers believe that the outcomes of their actions are contingent with what they do (Brown, Westenskow, & Moyer-Packenham, 2012).

The most effective way of creating a strong sense of efficacy is through mastery experience (teacher successes) (Bandura, 1997). Without these experiences we are more likely to discover low teacher efficacy, whereby there exists high levels of mathematical anxiety and low teacher confidence, with teachers doubting their capabilities as educators (Haciomeroglu, 2013). These teachers tend to have an “external locus of control” in that they believe that outcomes are independent of their decisions (Brown et al., 2012).

Teacher efficacy affects how teachers function through the following four psychological processes (Bandura, 1994). The selection process is when teacher efficacy influences the types of activities and environments teachers choose. For example,
teachers with low teaching efficacy will avoid lessons they believe exceed their capabilities and choose lessons with little risk (usually through a traditional approach). The affective process refers to the impact of teacher efficacy on their control over negative feelings. Teachers with low teacher efficacy experience high levels of anxiety due to their irrational thought process that impairs their ability to function. The motivational process relates to the influence of teacher efficacy over their beliefs surrounding their abilities as educators, which in turn, leads directly to success or failure. Teachers with a high sense of efficacy are able to motivate and self-regulate, enabling them to persist through difficult moments, and accomplish their objectives. Lastly, the cognitive process is when teacher efficacy influences goal setting. Teachers with high efficacy are able to visualize success scenarios and set more specific and challenging goals.

Efficacy affects the goals teachers set for themselves, the effort they invest in reaching those goals, and their persistence with facing difficult scenarios (Ross & Bruce, 2007). Both goal setting and effort affect the teaching of mathematics, as we turn to examine the extent of this influence in greater detail below.

Goal orientation theorists believe that teachers’ goal orientations affect and reflect their instructional practices (Schunk, Pintrich, & Meece, 2008). Two types of goal orientation exist: mastery goal orientation where success is evaluated in terms of self-improvement, and performance goal orientation where success is evaluated in comparison to others (Throndsen & Turmo, 2013). Teachers with performance goal orientation enable competition for good grades in their classrooms or the comparison of students’ performance and abilities; this contributes to forming students who are more
likely to give up on math work when it is difficult or boring, perform worse on mathematics tests or pay less attention in math classes (Lau & Nie, 2008).

Conversely, teachers with a mastery goal orientation are greater focused on learning, developing new skills and use learning strategies that enhance understanding. Consequently, students who perceive their classroom as having this approach tend to perform better in math tests, report higher levels of effort in their math work and are less likely to give up when the work is difficult or boring (Lau & Nie, 2008).

Teachers are more likely to use teaching strategies that reflect their personal goal orientation. Throndsen and Turmo’s (2013) study examined primary mathematics teachers’ personal goal orientations for teaching, and their instructional practices. The participants were Norwegian primary mathematic teachers who taught students in teams of teachers. The findings showed that teachers, who seek new learning opportunities and aim to obtain new skills, tend to create a mastery goal structure in the classroom. The results from this study indicated that teachers were more oriented towards mastery goals than performance goals for their students.

When it came to teachers’ approaches to instruction, the findings demonstrated that they had the same pattern as teachers’ goal structure. This indicated that teachers’ instructional strategies in mathematics reflected a mastery orientation to learning. Students from the study, who perceived that their classroom, through their teacher’s use of instructional strategies, emphasized effort and understanding, were more likely to adopt the mastery goal orientation themselves. Therefore, mathematics teachers that are more oriented to mastery goals use mastery approaches, focus on the learning process,
develop new skills and improve student competence, which made a difference in terms of students’ mathematics achievement (Throndsen & Turmo, 2013).

The teaching of mathematics is also affected by the amount of effort exercised by teachers. Teachers who have high efficacy believe they have an impact on student success and thus exert more effort on students with different abilities and levels of interest (Finnegan, 2013). Teachers who exerted more effort facilitated collaborative and individualized activities, for example problem-based learning and cross-age peer tutoring (Tollefson, 2000). These types of teachers are more open to new ideas, are willing to experiment with new methods in their classroom practice, and persist through difficult student situations (Tschannen-Moran & Woolfolk Hoy, 2001). On the contrary, low teacher efficacy led to correspondingly low teacher effort, which resulted in the inability to cope with stressful demands and increased emotional exhaustion resulting in job burnout (Caprara, Barbaranelli, Borgogni, & Stecca, 2003; Schwarzer & Hallum, 2008; Skaalvik & Skaalvik, 2007 & 2010). Therefore, teachers who contribute to student success are those who have high teacher efficacy, set more challenging goals, exert more effort, which in turn leads to more challenging activities in their classroom (Schunk et al., 2008).

2.2.1 Relationship between Teacher Efficacy and Student Achievement

Several research studies have explored the effects that teacher efficacy has on student achievement (Archambault, Janosz, & Chouinard, 2012; Bruce et al., 2010; Mojavezi & Tamiz, 2012; Tournaki & Podell, 2005). Three major factors of how teacher efficacy contributed to student achievement are student expectations, student motivation and student self-efficacy.
Prior to the delivery of mathematics lessons, teacher efficacy predicts student outcomes; teachers either hold high or low expectations for their students. Student achievement increases when teachers with high teacher efficacy hold high expectations for their students (Archambault et al., 2012). With high expectations, teachers believe they can influence student learning and find ways to help their students succeed.

Mojavezi & Tamiz (2012) investigated the relationships between teacher self-efficacy, student motivation and student achievement. Their results supported Bandura (1994), who found that teachers “who have a high sense of efficacy about their teaching capabilities can motivate their students and enhance their cognitive development” (p. 11). Motivation has a positive effect on student achievement; the findings from Sarwar, Zerpa, Hachey, Simon, and Van Barneveld (2012) indicated that two student motivation components, task-value and effort, were positive predictors of overall student achievement in mathematics.

Teacher efficacy can also affect student self-efficacy (Siegle, & McCoach, 2007). In order for students to improve cognitively and affect their outcomes in mathematics, they need to develop a sense of agency for their own learning and mathematics self-efficacy. Siegle and McCoach (2007) investigated 872 fifth-grade students and 40 classroom teachers from six states across the United States in a study where the teachers from the treatment group were taught self-efficacy strategies and how to implement them. After teaching a mathematics measurement unit, it was revealed that students’ mathematics self-efficacy had a significant positive association with student achievement in mathematics. Thus, students who believe they are capable of doing well in mathematics are more likely to have high mathematics scores.
Students’ negative beliefs towards mathematics are of great concern. In a recent publication by the Ontario Ministry of Education (2014) in its research-into-practice series, Lynda Colgan, mathematics educator at the Faculty of Education, Queen’s University, states: “Ontario students are sending a loud and clear message – they are telling us they do not feel confident in math, they do not think they will do well in math and they do not like math” (p. 4). This message resulted from Ontario’s Education Quality and Accountability Office (EQAO) survey data on student attitudes towards mathematics. The report shows that, in the 2012-2013 academic year, only 44% of grade 6 female students and 58% of grade 6 male students in Ontario believe they are good at mathematics. Worse still, only 28% of grade 6 female students and 44% of grade 6 male students believe they can do difficult mathematics questions.

There is a clear and distinct correlation between student beliefs in their mathematics achievement and their actual mathematics achievement. This is proven by the EQAO mathematics results, where only 57% of the grade 6 students in 2012-2013 were at or above provincial standards (level 3 and 4). Thus, students who demonstrate a positive attitude towards mathematics and believe that they can do difficult mathematics tasks are more successful in mathematics. In contrast, students who believe they are not good at mathematics or fear mathematics hinders their learning therefore are academically unsuccessful.

2.2.2 Process of Effective Goal Setting

The incorporation and implementation of appropriate teacher goals is an integral component of effective education programs. This is highlighted by Mike Schmoker (1996) who stated that “the introduction of specific, measurable goals is among the most
promising yet underused strategy we can introduce into school improvement efforts” (p. 18). Our school’s success, therefore, is inextricably linked to the design and inclusion of these clear and measurable goals. While there are many approaches to setting effective goals, this next section closely examines three specific methods in particular, that is, 4C F goals, SMART goals, and POWER goals.

The first method, 4C F goals, is derived from the academic research of Edwin Locke and Gary Latham who provide five fundamental principles in order to set effective goals (Locke & Latham, 2002; Locke, Shaw, Saari, & Latham, 1981; Team FME, 2013). The first principal is Clarity, which claims that goals should state exactly what they want to achieve in a clear and concise manner, in addition to the period of time required to accomplish the goal. The second principle is Challenge, stating that goals should be set at the appropriate degree of challenge, in that they should be sufficiently difficult without inhibiting the goal setter’s confidence necessary to achieving their goal. The third principle is that of Complexity, whereby goals should be composed of multiple components as long as they form a coherent whole. The fourth principle is Commitment, highlighting the need on behalf of the goal setter to analyze the resources available in order to have an appropriate level of commitment. The final fundamental principle is Feedback, which describes the value of monitoring progress, reflection and receiving feedback as being vital for goal achievement. It is important that we remain cognizant of these five principles of effective goal setting as we move now to examine the improvement of our students’ learning.

In order to improve student learning, many teachers rely upon the method of SMART goals (O’Neill, 2000). A S.M.A.R.T. goal is defined as one that is specific,
measurable, attainable, results-based, and time-bound (O’Neill & Conzemius, 2005). Goals should have Specific expectations, targeting areas of academic achievement. They should define what the teacher is going to do and include clear descriptions of the knowledge and skills that will be taught. Goals should also be Measurable so that the teacher has tangible evidence of how much progress the students have made to accomplish the goal. Goals should be Achievable and realistic in that they are challenging for students, but students should possess the appropriate knowledge, skill and abilities needed in order to be successful. Goals should also be Relevant to the students’ learning strengths and needs. Lastly, goals should be linked to a Timeframe, whereby expectations are written in such a way that they are attainable within a specific time limit that also allow progress to be monitored at regular intervals. The successful implementation of these SMART goals help educators test the effectiveness of their instructional programs and see whether it makes a difference in student learning (O’Neill, 2000).

An approach to goal setting that may be more rigorous, holistic and research-informed than the SMART goal approach is the third method, a well-formed outcomes framework that uses the prompt P.O.W.E.R. to describe the five components (Day & Tossey, 2011). The first component is based on making goals that have Positive outcomes; the goal setter should be in a “wish for” state and set a goal they seek to achieve, not the one that they wish to leave behind. Secondly, it is about knowing your Own role; the goal setters set an outcome that can be achieved as a result of their own actions, and not dependent on the activities of others. The third component is analyzing What specifically? It is an assessment of the starting point: it assesses current individual actions and resources, for example amount of time available. The fourth stage is Evidence
based, specifically sensory-based evidence, to know what they might see, hear, feel, taste or smell in order to know if they are making progress (or not) towards their outcome. 

*Relationship* is the last component; the goal setters will perform an “ecology check” where they analyze the effects on their relationships with other people as they move towards reaching their outcome. This exploration is vital to the POWER approach since it is used to reveal the blockers that might prevent them from achieving the outcome and gives them an opportunity to problem solve or readjust their objectives.

The five characteristics of this approach can help educators implement their desired instructional practices. When selecting the desired objective, Day and Tossey (2011) state: “the outcome needs to be sufficiently significant so as to be motivating but not so large as to be overwhelming” (p. 524). By using the well-formed outcomes framework and setting realistic, challenging goals, which were previously out of reach, will result in improved teaching practices.

### 2.3 The Ten Dimensions of Mathematics Education

To better understand the teaching and learning of mathematics, Doug McDougall and John Ross designed a framework to support mathematics improvement (McDougall, 2004; McDougall, Ross, & Ben Jaafar, 2006). The framework, called the Ten Dimensions of Mathematics Education, suggests that teachers who work at the higher levels of these dimensions attain higher student achievement (see Appendix A).

The first dimension is program scope and planning and it focuses on how the curriculum is being implemented. The curriculum is divided into strands that should be covered throughout the year. A connection between all strands can be made through “big ideas” and should be integrated within units and lessons. In order to ensure the proper
delivery of lessons, teachers are required to use three levels of planning: long range plans, unit plans and daily lesson plans.

Meeting individual needs is the second dimension and it is about ensuring that every student is able to understand and make sense of mathematics. In order to do so, teachers should use a variety of lesson styles and differentiated instruction. Teachers can use scaffolding, use problems that range in the degree of difficulty, use contexts familiar to students, or change group arrangements in order to recognize that students learn in different ways and at different rates.

The third dimension, called the learning environment, is comprised of a safe, positive and organized space where students learn mathematics. It is important for this environment to be inclusive and encouraging to allow students to be comfortable in taking risks. Teachers can facilitate this environment by practicing effective grouping strategies; this allows students to learn to take responsibility for completing assignments, helps students refine their mathematical terminology, and helps them clarify concepts by sharing solutions with one another. A positive learning environment also includes ongoing teacher feedback and student input.

In the next dimension, student tasks, teachers should aim to use an appropriate balance of mathematical tasks in their mathematics classrooms. A balanced approach should include the practice of skills, application of procedures and rich problem solving. Rich tasks should focus on the process of arriving at a solution rather than the right answer. Engaging students to practice skills and apply procedures can be accomplished through the use of contexts, games or puzzles.
Constructing knowledge, dimension five, is about helping students learn by using the constructivist approach and effective teacher questioning. Teachers recognize that students bring prior knowledge as they construct their own knowledge. Teachers can guide the direction of inquiry and develop mathematical thinking by setting up appropriate tasks and use effective questioning. A good questioning technique, such as allowing wait time after asking a question, delaying reaction to student responses, or rewarding the act of responding rather than the response, helps students construct knowledge.

The sixth dimension, communicating with parents, is about how teachers interact with parents to ensure that their child is successful in mathematics. With parent communication, there are two factors to consider: the message to be communicated and the medium through which to communicate the message. It is important that teachers communicate with parents regularly through a variety of ways such as report cards, phone calls, e-mails, newsletters, agenda comments, face-to-face interactions and classroom displays.

Dimension seven is about using the appropriate manipulatives and technology in the mathematics classroom. Manipulatives help students visualize concepts as they model mathematical ideas concretely. Of course, teachers must have access to sufficient quantities of manipulatives and use them properly in order for them to be effective. Technology provides students with alternative representations of mathematical concepts and should at the very least be integrated as required by the curriculum.

Students’ mathematical communication, dimension eight, focuses on different forms of communication in the classroom such as oral, written and physical
communication. Regardless of what type of communication students choose, it helps students develop their thoughts and it makes mathematical thinking observable.

The ninth dimension is assessment and it is composed of three types of assessments: diagnostic, formative and summative. It is important that teachers implement a variety of assessment strategies, such as scoring guides, rubrics, and anecdotal comments, so that students can understand their errors, learn from it and show improvement in the next attempt.

The last dimension focuses on teachers’ attitude and comfort with mathematics. A positive attitude toward the teaching of mathematics is integral for teachers, as they act as role models for their students, with their own views on mathematics having the potential to directly influence student performance. It is also important for teachers to be comfortable with mathematical content because they are able to better explain why it is essential to learn math and can help students understand real world connections.

The Ten Dimensions of Mathematics Education is a vital component of a successful, dynamic, and complex mathematics program (McDougall, 2004). Rather than a generalized approach to teacher change, these dimensions help teachers break down all of the aspects of teaching into more manageable components. Focusing on one or two dimensions at a time helps teachers be more effective at improving their teaching practices and reaching their goals. Furthermore, these dimensions can be used to help guide the school improvement plan in order to get closer to meeting the standards set out by the NCTM (2000).

The Ten Dimensions of Mathematics Education comes with self-assessment tools such as the Attitudes and Practices for Teaching Math Survey and the Continuum in order
to help teachers improve their teaching beliefs and practices. For my thesis, I have decided to use these dimensions and tools as a framework to explore how teacher beliefs affect their teaching goals. I feel that using this framework will better enable me to see in which aspect of mathematics teachers are most or least aligned with current mathematics education thinking, and to see if using these tools can enhance the goal setting process.

2.4 Influencing Factors that Help Identify and Construct Teachers’ Goals

2.4.1 Professional Development

Teaching approaches vary; some educators consider the traditional approach as the best way to increase student achievement and others believe in the reformed based approach instead (Shoenfeld, 2004). There are several contradicting studies on the “best” mathematics teaching practices. For example, Kroesbergen, Van Luit, and Maas’ (2004) study revealed that low-achieving students improved significantly more than that of students in the constructivist condition when experiencing explicit teaching of a small but adequate repertoire of strategies, and when given explanations of how and when to apply them effectively. The findings demonstrated that reformed mathematics teaching practices, where students are required to construct their own knowledge, may not be effective for low achieving students.

A contrasting example is seen in Boaler’s (2008) study where the students benefited most in classroom environments where conceptual problems had a variety of possible solutions rather than one right answer. These two contrasting examples that are among countless other contrasting research findings show that mathematics instruction practices vary immensely among teachers. However, these results derive from teachers’ willingness to learn and find new strategies that will result in higher student achievement.
Professional learning can be defined as teachers’ ongoing learning to improve the way they teach. Professional learning can be informal, such as sharing ideas with colleagues or formal, such as presentations, hands-on workshops or collaborative meetings.

The Ontario’s Ministry of Education established the Working Table on Teacher Development in 2005 in order to provide advice and recommendations on issues related to teacher professional development to the Education Partnership Table (a group that provides insight to the provincial education policy early in the government’s policy development process) (Ontario Ministry of Education, 2007). In phase one, they added two professional activity days per school year in addition to the existing four. In addition, they implemented the New Teacher Induction Plan (NTIP), a program that supports first year teachers by training them on effective teaching, learning and assessment practices.

In the second phase, the Working Table determined five characteristics of successful teacher professional learning: coherence, attentiveness to adult learning styles, goal-oriented, sustainable, and evidence-informed (Ontario Ministry of Education, 2007). The first characteristic emphasizes that any type of professional learning must have a positive impact on the students and focus on student learning and development. Secondly, each professional learning experience should provide choice and differentiation in the content, be meaningful and relevant, understand that “one size fits all” approach does not facilitate student learning and finally, there should be recognition provided for attendance. The third characteristic is that professional learning should have clear, respectful goals and focus on improving student learning and achievement, and connect to daily practice. The fourth characteristic expects professional learning to be a process, be supported by appropriate resources, be job embedded, and allow time for self-
assessment. The last characteristic requires professional learning to be built upon current research to ensure that the needs of teachers and students would be up-to-date with theories and practices.

A good example that exemplifies the recommendations by the Ontario Ministry of Education is the integrated approach to teacher professional development created by Antoniou and Kyriakides (2013). This Dynamic Integrated Approach (DIA) has five distinct characteristics. First, rather than focusing on an isolated teacher factor for each teacher training session, this approach focuses on how to address specific groupings of teacher factors associated with student learning. Secondly, the DIA takes into account the importance of recognizing the fact that each teacher has specific needs in terms of improvement, suggesting that the content of the professional learning sessions should vary accordingly. Next, it helps teachers develop a clear understanding of why the factors addressed in their professional development sessions have an impact on student learning. The fourth characteristic involves supporting the coordinating team since they have an important role in facilitating and coaching teachers to successfully develop a plan and implement it in their classrooms.

Lastly, an important characteristic of the DIA is conducting summative evaluations in order to recognize the impact that the professional learning sessions had on the participants’ teaching skills and the effect it has had on student achievement. After implementing these five characteristics of the DIA to teacher professional development for one year, the findings suggest that reflection is more effective when teacher improvement priorities are identified and when teachers are encouraged to develop action plans that address their specific needs (Antoniou & Kyriakides, 2013).
The professional learning of practicing mathematics teachers is crucial in order to provide high quality mathematics learning to all students. Goldsmith, Doerr, and Lewis (2014) reviewed 106 articles written between 1985 and 2008 related to the teachers’ professional learning regarding mathematics. They found that existing literature generally lacks consistent descriptions of professional learning and that existing research tends to focus on program effectiveness rather than on teachers’ learning. According to the research, professional learning sessions often occur in sequential incremental changes of knowledge, beliefs, dispositions, and classroom practices, rather than being a direct path from a single professional development experience that is intended to change practice resulting in improvement in student outcomes. In addition, findings indicated that professional development varies across individuals and context.

Rather than designing standard programs, professional learning sessions should focus on what learning looks like for teachers with different belief and knowledge systems, different settings, and different pedagogical practices in order to promote teachers’ learning. Goldsmith, Doerr, and Lewis (2014) suggest that future research on mathematics teachers’ learning should focus on developing shared conceptual frameworks, develop standards for descriptions of professional development programs, and develop common and rigorous reporting practices.

2.4.2 Collaboration

While there has historically been a predominantly traditional school culture dominating our education systems, we have recently seen a shift towards a more collaborative approach that strives to foster cooperation amongst teachers rather than our previous tendency to work in isolation (Johnston, Knight, & Miller, 2007). According to
Johnston, Knight, and Miller (2007), these collaborative environments succeed in improving student achievement by allowing teachers to work together on instructional strategies, designing common assessments and co-constructing curricular plans. This systematic and deliberate effort to collaborate leads to the construction of teacher teams, groupings that are created by principals according to their grade-level and are comprised of three to four people that meet weekly all year round. The time allotted for teacher collaboration is valued since it enables them to build peer relationships and hold one another accountable for reaching their individual classroom goals.

Owen (2013) conducted a research study that analyzed the relationship between teacher learning within a professional learning community context and student learning outcomes. The findings revealed that teacher teams allowed members to keep one another accountable and supported them to positively change their beliefs and practices. All of the teachers and leaders in the school facilitated the change process from teacher isolation to teacher collaboration by constantly reinforcing the importance of the professional learning communities and ongoing learning. Teachers worked together on inquiry-based, student-centered practical activities to develop joint values.

In their professional learning communities, teachers acquired new pedagogies, such as improved questioning, for dealing with disengaged students. They also had the opportunity to co-teach, co-observe, co-plan, and co-reflect activities that subsequently led to more active and creative materials being used in the classroom, which, in turn, resulted in higher student achievement (Owen, 2013). In addition, teachers benefited from the emotional support arising from this collegial approach and increased their self-confidence and self-efficacy as a direct result.
However, teachers were not the only ones advocating the implementation of team teaching, as students’ feedback on the initiative was also overwhelmingly positive in nature (Owen, 2013). The students highlighted the opportunity of having the same concept delivered in a variety of ways as the biggest advantage to this approach. Positive student responses resulted from teachers’ professional learning communities that enabled them to co-plan in order to create more innovative learning experiences for students, use game based technology, and provide opportunities for students to experience new learning practices through co-teaching that involved more teacher interactions.

While the literature presents many convincing arguments for the implantation of teacher-teams, there are also questions surrounding the strength of the link between student achievement and teacher collaboration. A direct link between student achievement and teacher collaboration could not be confirmed by Moolenaar, Sleegers, and Daly’s (2012) study. Nevertheless, their findings showed that, when teachers shared experiences, planned collective goals, and profited from their advice networks, it positively affected their perceptions of collective efficacy, which was associated with increased student achievement. Teacher teams who had high collective efficacy beliefs, for example teachers who felt that they were able to motivate and challenge the most difficult students, were teaching in schools that achieved higher student performance.

In order to provide further verification of these teacher collaboration initiatives, Ronfeldt, Owens Farmer, McQueen, and Grissom (2015) investigated the different types of collaboration among teacher colleagues, while also analyzing whether or not these collaborations could be viewed as a predictor of student achievement. The results showed that, as teachers engage in better collaboration, students gain higher achievement in both
numeracy and literacy. The findings demonstrated that teachers’ rate of improvement increased when they worked together. Collaborating did improve their instructional practices, which resulted in higher student achievement scores. The various teacher teams who worked on improving teaching practices reported the domains that were helpful for most teachers were formative assessment and developing instructional strategies. In addition, teachers truly valued this experience and made good use of the time that they were given to collaborate.

Professional teacher collaboration not only benefits teachers and students but it also positively affects the school (Forte & Fores, 2014). Forte and Fores (2014) found that teacher collaboration created a better school atmosphere, which resulted in better outcomes on school projects. It also helped the school gain a better reputation, and it increased the involvement with the community, which fostered communication with parents. For teachers, collaborating with their colleagues affected them on both professional and personal levels. In the professional domain, teachers formed stronger relationships with their colleagues since they felt they were part of a team and were willing to share their ideas and experiences. It also gave some teachers a critical awareness; discussions with other colleagues led them to feel that they also needed to improve in new areas of their teaching practices. In the personal domain, teachers showed an increase in job satisfaction since they felt that their work was recognized. As teachers learnt new pedagogies and improved on student tasks, students benefited from those new experiences and developed new skills, which resulted in higher student achievement.

According to the Ministry of Education (2010), collaborative teacher inquiry is rapidly becoming a common, important component of professional practice in Ontario.
The shared process among teachers plays a critical role in teacher inquiry: “collaboration provides perspective, diversity and space for teachers to consider questions about student learning that can provide new insight available in inquiry processes that are done individually” (Ministry of Education, 2010, p. 3). Through collaborative inquiry, teachers integrate new knowledge and understanding of student learning and classroom instruction into their existing knowledge of professional practice. A supportive teacher network nurtures teachers’ confidence to achieve school goals and having strong teacher relationships in a school fosters positive working environments that contribute to higher student achievement. In closing, the research literature shows that school environments appear to be shifting from teacher isolation towards teacher collaboration, and higher student achievement is resulting from teachers working together to co-plan and co-teach their lessons.

2.4.3 Parental Involvement

2.4.3.1 Academic Achievement due to Parent Involvement

The way in which parents are contributing to their child’s education and the extent and frequency of their involvement can influence students’ mathematics grades (Levpuscek & Zupancic, 2009). In a study of 365 eight graders who reported on their parents’ academic involvement, Levpuscek and Zupancic (2009) found that parents increased their involvement with the school once their child experienced academic failure. The parents of these low mathematics achievers would then start providing more academic support. This came with strong academic pressure, which hindered students’ mastery goal orientation, sense of academic self-efficacy and academic success.
Therefore, the results showed that there is a negative direct link between student perception of parental academic support and mathematic achievement.

Students who struggle with academics tend to feel pressure from their parents to perform better academically. However, constant parental academic support is positively related to student mastery goal orientation in mathematics, resulting in high student self-efficacy, which influences their final mathematics grades.

Academic achievement is affected by the student’s family environment and parental involvement in the school (Jones & White, 2000). Several factors, that comes from the family context, such as the parents’ education level or their school experiences, influence the extent of their involvement in their child’s schooling. In Jones and White’s (2000) study, students’ academic performance on mathematic and language tests were linked to parents’ participation in volunteering and attending school related activities. However, findings showed that parental involvement alone was not enough to influence children’s achievement in school. Instead, the factors that influenced students’ score on achievement tests were parent’s education level, and the type of activities in which parents participated with their children. Therefore, the results showed that parents’ participation in school activities at home would have more influence on students’ academic achievement than volunteering in school or attending school activities.

2.4.3.2 Student Perceptions of Parental Involvement

Fan and Williams (2010) found that the objectives and educational intentions that parents had for their children positively affected students’ academic self-efficacy, engagement and motivation in mathematics. Three factors contributed to student success. First, students who perceived that their parents valued their education and had high
expectations for their academic success were likely to feel interested, engaged and confident toward their academic tasks. Second, parents who had educational values for themselves influenced students to become interested in pursuing those goals as their own. Lastly, parent involvement in the school had a positive association with students’ mathematics self-efficacy, resulting in academic success.

Results from Fan and Williams’ (2010) study showed that parents were more likely to provide guidance and communicate with their children in a positive manner if there was school-initiated contact regarding academic programming, future educational plans, and how to help students at home. Early teacher-initiated communication with parents would benefit students’ perceived competence, engagement, and intrinsic motivation. On the contrary, if parent-school communication occurred only when there was a concern with the student’s poor performance or behavioral problems, this would lead to discouraging conversations, criticisms, or punishments from parents, which in turn reduced student confidence, interest and engagement from learning.

2.4.3.3 Obstacles for Parental Involvement

Flynn (2007) identified several obstacles for establishing good parent communication. Malfunctioning parent communication is due to two types of obstacles: there are obstacles for parents in why they choose not to get involved and there are obstacles for teachers as to why they have weak parental engagement. Some of the main reasons why parents are reluctant to communicate with their child’s teachers are because the only time they talk to teachers is when there is a problem, their previous personal negative experiences with school or due to the belief that teachers do not make enough effort to understand their own child. Other reasons for holding parents back from talking
to teachers are language barriers, teacher jargon, some parents do not value the
importance of education, some parents feel that they lack the sufficient skills in order to
help their children with their homework, and sadly, some parents believe that it is solely
the teacher’s responsibility to take care of their children during school hours.

Teachers also experience obstacles for contacting parents. Many teachers fear that
parents will be argumentative, and that parents do not value education or that they do not
make an effort to motivate their children for learning. Some teachers believe that
contacting parents is not part of their job description and some teachers simply do not
understand the importance of parental involvement. In addition, Flynn (2007) reported
that teacher education programs do not adequately prepare teachers to increase parental
involvement in the school.

2.4.3.4 Opportunities to Increase Parental Involvement

One of the main issues with the absence of parental engagement in the school is
the lack of pre-service teacher training on parental involvement. Hoover-Dempsey,
Walker, Jones, and Reed’s (2002) study tested out a new Teachers Involving Parents
(TIP) program, which helped shape teachers’ beliefs and behaviors in increasing parental
involvement in the school. The TIP program successfully helped change teachers’ beliefs
when it came to the perception of parents’ efficacy for helping children learn and be
involved. Additionally, this program supported the development of teachers’ sense of
teaching efficacy. The TIP program effectively increased teacher invitations for parental
involvement, implying that similar programs should be embedded as part of teacher
education programs.
Civil and Bernier’s (2006) research article explains a program, MAPPS, whose main goal is to involve parents in order to improve students’ academic achievement. The research project was composed of several schools in three different states over a period of four years. Math and Parent Partners (MAPPS) is an outreach program to get parents involved in their child’s education. The goal of the program is to develop leadership teams composed of parents, teachers, and administrators to work together on mathematics education. MAPPS is made up of three components: leadership development sessions, math awareness workshops (MAWS), and sessions for parents to learn mathematics (MFP). The leadership sessions are designed to break traditional power structures between teachers and parents, and instead allow them to work together.

The math awareness workshops illustrate key topics taken from the elementary and secondary mathematics curriculum. The parent math sessions give them an opportunity to explore the mathematics topics they would like to go more in depth with. Positive results emerged from this project: parents participated to help their children, they developed an appreciation and understanding for mathematics, they became positive educational role models for their children, and they interacted with their child’s teacher.

2.5 Summary

Recent research shows that teacher efficacy affects teachers’ goal setting process and the goal orientation they choose influences their instructional practices, which ultimately impacts student learning (Schunk, Pintrich, & Meece, 2008). Teachers with high efficacy beliefs have high expectations for their students and have an overall positive attitude towards teaching (Tschamen, Moran, & Woolfolk Hoy, 2001). They hold high expectations for their students and are more willing to motivate their students
academically (Archambault et al., 2012; Mojavezi & Tamiz, 2012). On the contrary, teachers with low efficacy beliefs do not set appropriate teaching goals, are unable to achieve their objectives, and avoid lessons that exceed their capability, leaving them to choose low risk tasks, and thus are less confident and experience high levels of mathematics anxiety (Bandura, 1994; Haciomeroglu, 2013).

Effective goal setting strategies such as the 4C F goals, SMART goals or POWER goals, are used to help teachers set purposeful goals that relate to their teaching practices. The Ten Dimensions of Mathematics Education (McDougall, 2004) is the framework that is used in this study as a guide to help the teachers to develop specific and clear goals. Additionally, it provides insights on how teachers’ beliefs affect their teaching goals.

Other factors that influence how or why teachers choose their teaching goals are also addressed. Professional development, collaboration, and parental involvement are the three possible influencing factors. According to the Ontario Ministry of Education (2007), one of the characteristics of successful teacher development is having clear goals that focus on improving student learning and connects to daily teaching practices. Furthermore, a collaborative environment is needed because it is a critical component to improve student achievement (Johnston, Knight, & Miller, 2007). When teachers co-plan and co-teach, they develop creative academic materials and pedagogy that result in higher achievement (Owen, 2013). Academic performance was also linked to parents’ involvement with the school and higher achievement resulted from students who perceived that their parents valued education and had high expectations for their academic success (Jones & White, 2000; Fan & Williams, 2010).
Chapter Three: Methodology

3.1 Introduction

This section examines the progress of four Grade 6 teachers as they partake in a series of professional learning sessions. The fundamental goal shared by these teachers was a desire to improve their teaching practices in order to better address their students learning needs.

I begin by firstly outlining the research context and design structure that, in turn, provide an accurate and detailed description of each participant in the study and their school context. In addition to the data collection process, the data analysis is explained and a description of the ethical considerations is provided.

3.2 Research Context

Upon reviewing and analyzing the literature, I have selected a constructivist paradigm for the purpose of this study. This is primarily due to the fact that my research revolves around an exploration of teachers’ attitudes towards mathematics and how these affect their educational goals of mathematics teaching. The driving focus of constructivist research is to understand and interpret the meaning of lived experiences in order to inform practice (Lincoln et al., 2013). Indeed, Lincoln, Lynham, and Guba (2013) state: “We construct knowledge through our lived experiences and through our interactions with other members of society…as researchers, we must participate in the research process with our subjects to ensure we are producing knowledge that is reflective of their reality” (p. 210).

The close collaboration between the participants and myself, the researcher, enabled the participants to feel comfortable in sharing their personal teaching
experiences, which included reflecting upon their core beliefs and goals for teaching mathematics. As Guba (1990) states: “the inquirer and inquired into are fused into a single entity. Findings are literally the creation of the process of interaction between the two” (p. 27). Given that the primary intent of this study is to provide a description of how teachers’ beliefs and attitudes as well as other factors influence their professional mathematics teaching goals, I conclude that the constructivist paradigm is the most suitable for this research.

3.3 Research Design

A qualitative study was conducted in order to determine the ways in which educators construct their teaching goals and to examine other potential factors that influence these objectives. Hesse-Biber and Leavy (2011) state: “Qualitative research seeks to unearth and understand meaning…[it] examines how the meanings we assign to our experiences, situations, and social events shape our attitudes, experiences, and social realities” (p. 12).

In this study, I use a case study method. Creswell (2007) explains: “Case study research involves the study of an issue explored through one or more cases within a bounded system (i.e., a setting, a context)” (p. 73). Each teacher participant has his or her own individual case that is bounded within the school context. Then the findings from each individual case were re-analyzed in a cross-case comparison. Creswell (2012) further explains: “studying multiple cases allowed us to see processes and outcomes across all cases and enabled a deeper understanding through more powerful descriptions and explanations” (p. 45). A cross-case study strategy explains the causal links in each
context that is too complex for one single case study and adds validity to the findings through replication logic (Yin, 1994).

3.4 Participants

The participants for this study are teachers and principals that were involved in OISE’s Grade 3-6 Math Project, led by Doug McDougall and Sue Ferguson. The Grade 3-6 Math project was a series of four professional development sessions aimed at improving the teaching of mathematics at the elementary school level. Superintendents chose selected schools to participate because they had low mathematics scores and they had mathematics improvement in their school improvement plans. Participants who attended the professional development sessions were elementary school teachers from Grades 3 to 6 (a total of 29) and their corresponding principals (a total of 6). One school, Bruce Peninsula Middle School, was selected from the Grade 3-6 Math Project to be part of this study. Four teachers from this school are the participants of this study.

3.4.1 Participant 1: Jacob

Jacob has always wanted to make a difference in young people’s lives. Jacob has 13 years of teaching experience as well as a Master of Education. He has been at Bruce Peninsula Middle School for 11 years and has taught grades 6, 7 and 8. He currently teaches grade 6 and he is one of the leaders for Science, Technology, Engineering, and Mathematics education (STEM) and for athletics.

3.4.2 Participant 2: Sarah

Sarah completed her undergraduate studies in biological sciences at a university in Jamaica. She started her teaching career after completing her university studies by teaching at a community college. She then realized that she had a passion for teaching
and pursued her teaching certification. In Jamaica, Sarah has taught biology advanced profession examination courses, environmental and biological sciences, integrated science to grade 7 and 9, and biology to grades 10, 11, 12, 13. Since she has been in Canada, she has taught grades 2, 6, 7 and 8. With 12 years of teaching experience, Sarah loves learning and has completed some Additional Qualification (AQ) courses. She is currently in her fourth year at Bruce Peninsula Middle School as a Grade 6 teacher and the Grade 6 team leader.

3.4.3 Participant 3: Madelyn

Madelyn has always wanted to pursue the teaching profession. Her grade one teacher taught her more than just the course material and this is the main reason for Madelyn’s passion in teaching. Madelyn completed her university degree in Jamaica specializing in Elementary Education. In Jamaica, she taught grades 4, 5, and 6 for 26 years. Recently, she moved to Canada and worked as an occasional teacher. Madelyn started her first long term occasional position as a grade 6 teacher at Bruce Peninsula Middle School in September, at the beginning of this project.

3.4.4 Participant 4: Lindsay

Lindsay completed her undergraduate degree in political science and history. She worked for a government agency for 25 years and then decided to return to university to complete her Bachelor of Education. Lindsay feels that teaching is her calling rather than just a career and absolutely enjoys every second she spends in the classroom. Lindsay has been teaching for 6 years now and has taught grades 5 to 8, an autism program, and summer school ESL programs. She is currently teaching grade 6 at Bruce Peninsula Middle School, which she started in September, at the beginning of this project.
3.4.5 School Context

Located at the heart of a large urban area, one of the school’s strength is its diversity. In 1989, Bruce Peninsula became a middle school: grades 6 to 8. The school’s population for the 2014-2015 year was 483 students (composed of 243 female students and 249 male students). Half of the student population has a first language other than English and 15% of the student population was not born in Canada.

The results from the 2013-2014 Education Quality and Accountability Office (EQAO) Assessment of Reading, Writing, and Mathematics show that students are performing below the provincial standard (level 3 and 4) for reading, writing, and mathematics. The results from the 2014-2015 EQAO Assessments were not publicized when this thesis was written. The following tables compare the results in reading, writing, and mathematics for all grade 6 students from Bruce Peninsula and the Ontario province.

Table 1

*EQAO Results in Reading, Writing, and Mathematics, 2013-2014.*

<table>
<thead>
<tr>
<th>Grade 6: Reading</th>
<th>Bruce Peninsula</th>
<th>Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>3%</td>
<td>12%</td>
</tr>
<tr>
<td>Level 3</td>
<td>52%</td>
<td>67%</td>
</tr>
<tr>
<td>Level 2</td>
<td>30%</td>
<td>16%</td>
</tr>
<tr>
<td>Level 1</td>
<td>11%</td>
<td>2%</td>
</tr>
<tr>
<td>At or Above Provincial Standard (Level 3 and 4)</td>
<td>55%</td>
<td>79%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 6: Writing</th>
<th>Bruce Peninsula</th>
<th>Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td>Level 3</td>
<td>55%</td>
<td>66%</td>
</tr>
<tr>
<td>Level 2</td>
<td>25%</td>
<td>18%</td>
</tr>
<tr>
<td>Level 1</td>
<td>9%</td>
<td>1%</td>
</tr>
<tr>
<td>At or Above Provincial Standard (Level 3 and 4)</td>
<td>61%</td>
<td>78%</td>
</tr>
<tr>
<td>Grade 6: Mathematics</td>
<td>Bruce Peninsula</td>
<td>Province</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------</td>
<td>---------</td>
</tr>
<tr>
<td>Level 4</td>
<td>3%</td>
<td>13%</td>
</tr>
<tr>
<td>Level 3</td>
<td>26%</td>
<td>42%</td>
</tr>
<tr>
<td>Level 2</td>
<td>36%</td>
<td>30%</td>
</tr>
<tr>
<td>Level 1</td>
<td>31%</td>
<td>13%</td>
</tr>
<tr>
<td>At or Above Provincial Standard (Level 3 and 4)</td>
<td>29%</td>
<td>54%</td>
</tr>
</tbody>
</table>

Student achievement was tracked by EQAO for students who wrote the Grade 3 assessments in 2011 and then the Grade 6 assessments in 2014 in comparison with the provincial standard. The following table shows Bruce Peninsula students’ progress.

Table 2

\textit{EQAO Tracking Student Achievement in Relation to Provincial Standard, Primary (Grade 3) to Junior Division (Grade 6), 2010-2011 to 2013-2014}

<table>
<thead>
<tr>
<th>Bruce Peninsula Results (Grade 3 in 2011 &amp; Grade 6 in 2014)</th>
<th>Reading</th>
<th>Writing</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met the provincial standard in Grade 3 and Grade 6</td>
<td>41%</td>
<td>54%</td>
<td>29%</td>
</tr>
<tr>
<td>Did not meet the provincial standard in Grade 3 but met it in Grade 6</td>
<td>17%</td>
<td>9%</td>
<td>1%</td>
</tr>
<tr>
<td>Met the provincial standard in Grade 3 but did not meet it in Grade 6</td>
<td>11%</td>
<td>15%</td>
<td>31%</td>
</tr>
<tr>
<td>Did not meet the provincial standard in Grade 3 and did not in Grade 6</td>
<td>31%</td>
<td>22%</td>
<td>39%</td>
</tr>
</tbody>
</table>

3.5 Data Collection

The data collected for my thesis came from the \textit{Attitudes and Practices for Teaching Mathematics Survey} (McDougall, 2004; see Appendix B), individual participant interviews (see Appendix E), and field notes from the professional learning sessions. The data was collected between December 2014 and May 2015. All of the participants were involved in the Mathematics Improvement Project for Grades 3 to 6 (McDougall et al., 2015). The project’s focus was reforming mathematics practices and
consisted of four full-day professional learning sessions that were held at OISE.

The first session was held on December 1, 2014 where Doug McDougall, the principal investigator, and Sue Ferguson, the project coordinator, first outlined the overview of the project. Workshops on problem-solving mathematics followed the introduction and required teachers and principals to create open-ended student tasks. Then the *Ten Dimensions of Mathematics Education*, containing 10 items, was thoroughly explained to all participants (McDougall, 2004; see Appendix A). In order to assess teachers’ attitudes towards the teaching of mathematics, the participants completed the Attitudes and Practices for Teaching Mathematics Survey, a self-assessment tool. The survey included 20 questions using a 6-point Likert scale that describes the extent to which a participant agreed with each statement (from strongly disagree to strongly agree). Survey questions linked directly to the ten dimensions and allowed the participant to calculate a numerical score for each of the ten dimensions using a scoring chart (see Appendix B).

After taking the survey, participants and researchers could identify the dimensions in which their attitudes aligned with the current mathematics education thinking (high score, 4-6), and the dimensions in which they needed further professional growth (low score, 1-3). Using the survey results, the participants identified two dimensions for their personal professional goals to work on during the upcoming academic year. Additionally, the teachers from each school collectively picked two dimensions as their school team’s mathematics goals. Once completed, a copy of the survey from each participant was made for data analysis.

The second session was held on January 15, 2015 and there were several
workshops for the participants. The workshops focused on number sense, mathematical knowledge construction, student mathematics tasks, assessment and the use of manipulatives.

A month after this session, I conducted individual interviews with each participant at the Bruce Peninsula Middle School to gather information on their teaching experiences, their views in the teaching of mathematics, as well as their goals in mathematics education. The principal and teachers of the school were asked the same questions and interviews took between 35 and 50 minutes per participant. The questions were divided into six categories: background questions, versions of success, challenging circumstances, mathematics, fostering mathematics communication, school support, and overall questions (the list of questions can be seen in Appendix E). Each participant was given an information letter (see Appendix C) and a consent form (see Appendix D) to read and sign prior to the start of the interview. All the interviews were audio recorded.

The third session was held on March 31, 2015. The principal investigator and project coordinator presented a summary of their school visits. Some of the strengths presented were the proper use of the three-part lesson plan learnt in the previous learning session, the visibility of manipulatives in the classroom, the word-walls, examples of success criteria, and the use of I-pads in the primary classrooms. Suggestions for improvement were given: displaying student work rather than teacher posters, understanding the difference between learning goals versus success criteria, and displaying examples of student evaluation for a clearer understanding. This session was of most value to the participants, as indicated on their exit sheets at the end of the day. During the morning, they attended two hands-on workshops presented by OISE
professors. The workshops focused on place value and number sense. In the afternoon, teachers were divided into two groups to learn different ways of implementing computer software, Microsoft Excel and Geometer’s Sketchpad, for their teaching grades.

The fourth session was held on April 30, 2015. The workshops focused on pattern ing and algebra, mathematics tasks, technology uses and assessment. The participants completed the Attitudes and Practices for Teaching Mathematics survey again. They then had a chance to compare their current results with the results of the first professional learning session. They were given individual time as well as collaborative time to reflect on their changes in respects to their practices and beliefs towards the teaching and learning of mathematics.

3.6 Data Analysis

The analysis of the Attitudes and Practices to Teaching Math Survey was descriptive for each of the four cases. All of the semi-structured interview sessions were recorded and then transcribed. Data was briefly analyzed to come up with nine main code categories: collaboration, professional development, motivation, resources, success, goals, support, school, and character education. The data was then coded using the NVIVO software for common themes. The emerging themes were: teachers’ goals for students, collaboration, and six dimensions from the Ten Dimensions of Mathematics Education.

3.7 Ethical Considerations

Prior to the data collection of this thesis, there was an ethical review process that was completed as part of McDougall’s (2015) Grades 3-6 Math Research Project. All of the participants involved in the Grades 3-6 Math Research Project had the opportunity to
participate. Those who agreed to be part of this study signed a formal consent letter to confirm their participation (see Appendix C & D). The participants were not obligated to continue participating in this study and were able to withdraw voluntarily without consequences at anytime. Participants were reminded that pseudonyms would be used and all interviews would be confidential.

In addition, participants were also welcomed to request to view the findings prior to publication. Data collected throughout this study was stored in a safe place by the researcher and was only retrieved for data analysis. In order to ensure confidentiality, pseudonyms for all teachers, the principal and the school were used in this study. Any specific details about the teacher’s prior school they worked in and the location of all schools have been omitted.
Chapter Four: Findings

4.1 Introduction

In this thesis, I investigate elementary school teachers’ professional learning goals. By exploring four different case studies, the survey results and the data analysis revealed teachers’ professional learning goals for mathematics teaching, highlighting specific dimensions from the Ten Dimensions of Mathematics Education for each participant, as well as a general discussion about collaboration and parent communication.

4.2 Case study 1: Jacob

4.2.1 Survey Results

After taking the survey for the first time, Jacob scored most consistent with current mathematics education thinking on Dimensions 6: communicating with parents and Dimension 7: manipulatives and technology with a score of 5 out of 6. Jacob’s area of improvement for professional growth was Dimension 5: Constructing Knowledge with a score of 2.8 out of 6. Table 3 shows Jacob’s score for all dimensions (out of 6).

Table 3

<table>
<thead>
<tr>
<th>Jacob’s Dimensions Scores</th>
<th>December</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Ten Dimensions of Mathematics Education</strong></td>
<td><strong>December</strong></td>
<td><strong>April</strong></td>
</tr>
<tr>
<td>1. Program Scope and Planning</td>
<td>4.3</td>
<td>5</td>
</tr>
<tr>
<td>2. Meeting Individual Needs</td>
<td>4.4</td>
<td>4.6</td>
</tr>
<tr>
<td>3. Learning Environment</td>
<td>3.7</td>
<td>2.7</td>
</tr>
<tr>
<td>4. Student Tasks</td>
<td>4</td>
<td>4.6</td>
</tr>
<tr>
<td>5. Constructing Knowledge</td>
<td>2.8</td>
<td>3.2</td>
</tr>
<tr>
<td>6. Communicating with Parents</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7. Manipulatives and Technology</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>8. Students’ Mathematical Communication</td>
<td>4.8</td>
<td>4.3</td>
</tr>
<tr>
<td>9. Assessment</td>
<td>4.3</td>
<td>4.5</td>
</tr>
<tr>
<td>10. Teachers’ Attitude and Comfort with Mathematics</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td><strong>Overall Score</strong></td>
<td><strong>4.2</strong></td>
<td><strong>4.4</strong></td>
</tr>
</tbody>
</table>
Jacob mentioned in his interview that he had chosen Dimension 2 (meeting individual needs) for his personal growth. The reasoning behind choosing this dimension was “because all the students learn differently and not all are the same” (Teacher Interview, February 2015).

Overall, according to the survey results, Jacob improved from December to April. His overall score in December was 4.2 and increased to 4.4 by April. This indicates that, after the professional development sessions, Jacob became slightly more consistent with current mathematics education thinking and more receptive to change in his practice.

For the most part, Jacob’s score increased on each dimension. Jacob’s score improved the most on Dimension 6, communicating with parents, and his score fell the most on Dimension 3, the learning environment. There was an average score increase for all dimensions, except for dimensions 3 and 8.

4.2.2 Professional Learning Goals for Mathematics Teaching

Jacob loves teaching mathematics and loves to learn new strategies to help him improve his teaching. Since Jacob learnt mathematics from a traditional “drill, drill, drill” practice and understands that there is a push for the reformed teaching of mathematics, one of his goals is to get students to figure out open-ended questions on their own rather than simply telling them the answers. In working towards this goal, Jacob has a chart with prompt questions such as “What do I know? What don’t I know?” in order to help students acquire problem solving techniques.

Jacob’s main goal for the teaching of mathematics is teaching his students what is required by the curriculum and then going one step further by teaching them additional skills. He says: “what I like to do with math [is] push them more than what they need for
the curriculum…help them get prepared for next year and beyond” (Teacher Interview, February 2015). Jacob pushes his students to learn more than what is required by the Ministry of Education. In addition to adding extra skills from higher grades in his lessons, Jacob also runs lunchtime math lessons once a week to teach students in grade 8 the grade 9 material.

Jacob’s personal goal for education is to become a leader in the school. He hopes to become a principal in the future and is currently taking continuing education courses in order to accomplish that goal. Jacob also tries to provide more leadership in the school in addition to his role as a teacher.

In the following sections, I classify each of Jacob’s professional learning goals into one of the Ten Dimensions of Mathematics Education.

4.2.2.1 Student Tasks (Dimension 4)

One of Jacob’s mathematics teaching goals is to incorporate a variety of open-ended student tasks in his lessons, allowing there to be an opportunity for multiple solutions. His goal is best represented by dimension four, student tasks. In his Attitudes and Practices to Teaching Math survey Jacob scored 4/6 in December. He was then introduced to several new student tasks and activities in the professional learning sessions and as a result, his scored increased to 4.6/6 by April.

Jacob tries to diversify his lessons and activities to meet the needs of his students. In doing this he noticed that student participation increased when doing tasks that were challenging and applied to students’ daily lives:

The students get engaged, especially if they have a challenging activity…[for example] with the grade 6 class, they had to build their own bird feeder. They had to pick whatever bird they wanted to present and they could build it out of any material. [Each student] designed it, they drew a model, and then they put it
together. We had the STEM fair and the kids were so exited to present their bird feeder. (Teacher Interview, February, 2015)

Jacob particularly enjoys engaging his students through real-life contexts. He tries to connect each mathematical concept to a familiar student experience. For example, when learning fractions, Jacob links this Number Sense strand to cooking and baking. He provided a specific example:

Every time we have a birthday, someone brings a cake in. So I ask [my students]: “How many pieces are we going to cut this into? What is the size of the pieces that we have to cut the cake in?” So [I explain to them that] we are doing math all the time! (Teacher Interview, February, 2015)

Jacob believes in providing rich, real-life problems to his students because it increases student engagement in his mathematics lessons. Building upon his repertoire of student tasks is among Jacob’s professional learning goals. He described how professional development and teacher collaboration helped him gain new knowledge on how to create these rich tasks, enabling him to accomplishing his goal.

4.2.2.2 Constructing Knowledge (Dimension 5)

In order to develop and create student success, Jacob’s main teaching goal for mathematics is to ensure that his students fully grasp the mathematical concepts required by the Ontario Ministry of Education, and once they reach that objective, he pushes them to learn additional skills for the upcoming year. This goal belongs to the category of constructing students’ knowledge, Dimension 5. The results from both of the Attitudes and Practices to Teaching Math surveys showed that Jacob’s weakness was constructing knowledge (dimension 5). In December, he scored 2.8/6, and in April, after several professional learning sessions, Jacob’s score increased to 3.2/6. Despite the score’s
increment, Jacob’s teaching practices are still not aligned with current mathematical thinking.

The biggest challenge that Jacob faces is that his students do not know their basic, fundamental mathematics skills. Jacob learnt mathematics in a traditional way, which is very different from current mathematics education. He shares his personal outlook on the teaching of mathematics:

I do not know if you had to do this, but I had to stand up and everyone had to say their four times tables, the five times tables, etc….and if someone said it wrong, they would start all over again. But, I know my times tables! Right? So it worked! We do not do that anymore, I wish I could do [activities] like that drill work, but yeah…(Teacher Interview, February, 2015)

Since current mathematics education has deviated from the traditional methods that revolve around rote learning, Jacob no longer uses traditional activities, and instead supports his students’ learning through effective prompting and questioning techniques. He provides an example of his daily routine when teaching mathematics:

I always start off my math lessons with: “Well what part did you not understand?” Then, [the students say]: “Everything!” So, I read the question, I point at the chart, and I say: “Okay, what am I supposed to do? What do I know? What do I not know?” This way, the [students] have to go through that process every time so that they have a better understanding of how to approach the math question. Then, I help them out with what they do not know, and they figure out the rest on their own. (Teacher Interview, February, 2015)

Jacob also uses a variety of tools, such as group work, charts, open-ended questions, a math wall and competitive activities, in order to better facilitate and support students as they strive to maximize their potential. He explains that the math wall helps students grasp difficult mathematics vocabulary:

“Solve and simplify.” What does that mean? Right? So that is why we have a math wall, so that [the students] can look at the math wall and say: “Okay, these things all mean the same” (Teacher Interview, February, 2015)
All in all, Jacob’s main teaching goal lies within dimension 5, as he continuously tries to guide students’ individual and collective construction of mathematical knowledge through a constructivist approach.

4.2.2.3 Meeting Individual Needs (Dimension 2)

The dimension that Jacob chose for personal growth was meeting individual needs (dimension 2). Jacob explained that despite all his efforts to meet this goal, it was very challenging for him to meet each and every individual need of his students in a traditional setting. However, he found that if he provided more group work opportunities, then more individual needs were met. Jacob shares how student collaboration helped him meet his goal:

I had very limited success [with meeting individual needs]. Limited to the extent that I am satisfied…you always try different strategies…but what does help is group work. When they are in groups, now all of a sudden they are answering questions. When I put them in a group [setting], I put them at the level they are at…that provides a little bit of help. I can go and work with those struggling students, helping that group a little bit more. I enjoy doing that. I do that three times a week. (Teacher Interview, February, 2015)

Jacob aligns with the mathematics education reform regarding his belief of providing an appropriate level of support to every one of his students in order to engage them in problem solving and rich learning tasks. This is indicated by his survey results on the second dimension, meeting individual needs. Jacob first scored 4.4/6 and then 4.6/6 the second time, presenting high scores as well as a slight improvement from December to April. Jacob is able to differentiate his mathematics instruction for his students and subsequently he is receptive to other strategies that meet the individual needs of his students.
4.2.3 Collaboration

Jacob expresses that the school provides time for teachers to share their mathematics ideas with one another. He explains: “When we go to the staff meeting…we present what we are learning, so every staff meeting we come back and one of us would talk about different strategies that we use for math” (Teacher Interview, February 2015). Nonetheless, Jacob feels that, in the previous year, teachers tended to communicate and helped each other more. Jacob stated that there is a mathematics team at the school, however he has not seen any initiatives from their part. In his words: “this year I do not see as much, so lack of leadership, when it comes to math” (Teacher Interview, February 2015).

4.2.4 Communicating with Parents

Jacob believes that parent communication is an essential part of the school improvement plan, however, due to lack of communication, parent involvement became an obstacle for student progress in mathematics. Jacob shares his thoughts: “I think it is the biggest barrier…the communication between the parents, the child and the teacher…like a triangle, the triangle is broken” (Teacher Interview, February 2015).

4.3 Case study 2: Sarah

4.3.1 Survey Results

The survey results showed that Sarah’s lowest score was 4.4 out of 6 on Dimension 5: constructing knowledge. This suggested that Dimension 5 should be Sarah’s focus for personal growth and professional development. The results from Sarah’s first attempt at the Attitudes and Practices for Teaching Math survey showed perfect scores for Dimension 1: program scope and planning, Dimension 6:
communicating with parents, Dimension 7: manipulatives and technology, Dimension 8: students’ mathematical communication, and Dimension 10: teacher’s attitude and comfort with mathematics. Table 4 shows Sarah’s score for each dimension (out of 6).

Table 4

<table>
<thead>
<tr>
<th>The Ten Dimensions of Mathematics Education</th>
<th>December</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program Scope and Planning</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2. Meeting Individual Needs</td>
<td>4.6</td>
<td>5.2</td>
</tr>
<tr>
<td>3. Learning Environment</td>
<td>5.7</td>
<td>5.7</td>
</tr>
<tr>
<td>4. Student Tasks</td>
<td>4.6</td>
<td>5.2</td>
</tr>
<tr>
<td>5. Constructing Knowledge</td>
<td>4.4</td>
<td>5</td>
</tr>
<tr>
<td>6. Communicating with Parents</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7. Manipulatives and Technology</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>8. Students’ Mathematical Communication</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>9. Assessment</td>
<td>5.8</td>
<td>5.5</td>
</tr>
<tr>
<td>10. Teachers’ Attitude and Comfort with Mathematics</td>
<td>6</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Overall Score</strong></td>
<td><strong>5.4</strong></td>
<td><strong>5.5</strong></td>
</tr>
</tbody>
</table>

Sarah had a hard time recalling which dimension she had chosen for her personal growth. When trying to remember, she said that she was most likely working on Dimension 2: meeting individual needs and Dimension 9: assessment.

Sarah’s overall score improved slightly from December to April. Her initial average score was already high at 5.4, and after the professional development, her overall score went up slightly to 5.5. Sarah’s score indicates that her attitude and teaching practices are consistent with current mathematics education thinking and that she is open-minded to trying new ideas and strategies. Although Sarah’s results from April did not vary too much from December, an improvement is seen for Dimensions 2: meeting individual needs, Dimension 4: student tasks, and Dimension 5: constructing knowledge.

4.3.2 Professional Learning Goals for Mathematics Teaching

Sarah’s goal as a teacher is to meet each of her students’ needs in order to help
them perform at the best of their abilities. Sarah explains:

[My goal is] ultimately the success of every single student that I teach… I have to find what is the best path for each student based on their learning style and for me to formulate a plan that will really address their needs in order to achieve their ultimate success. (Teacher Interview, February 2015)

Sarah also strives to be a holistic teacher. She not only teaches her students content knowledge but also focuses on life skills:

It is for them to not just benefit academically but socially and emotionally from my input and my involvement, and to me that is success. It is not just academic, however that is the main focus but it is holistic. (Teacher Interview, February 2015)

Sarah’s goal for the teaching of mathematics is to make math meaningful. She wants her students to be able to apply mathematics to their daily lives: “My goal is for them to actually see math in action, in life, not just in the curriculum, not just in a textbook, I want them to have that experiential learning with math” (Teacher Interview, February 2015). Sarah is hoping that one day she can take her students to a supermarket so that they can see that math exists outside of the classroom; she wants students to realize that they interact with fractions and numerical operations on a daily basis.

Sarah’s second goal for mathematics is to help her students have higher order thinking skills. She wants her students to “develop a greater appreciation for the subject because I think there is a fear of math and [I want] to try to eliminate the fear, for them to really embrace [mathematics]” (Teacher Interview, February 2015).

Each of Sarah’s professional learning goals is classified into one of the Ten Dimensions of Mathematics Education in the upcoming sections.
4.3.2.1 Meeting Individual Needs (Dimension 2)

Sarah’s primary teaching goal is to meet the individual needs of her students, which from the Ten Dimensions of Mathematics Education it is categorized under Dimension 2.

When measuring student academic achievement, Sarah takes into consideration the diversity among her students’ learning needs. Sarah aims to differentiate instruction wherever possible and provides the various accommodations that her students require in order to succeed. Sarah finds joy in adapting to her students’ differences:

In math, I have seen students really improve, jumping from a level 2 to a level 3 because they were given the extra accommodations of additional time to complete their work. To see them just proving to themselves, to me and to their parents that they can do it is the most successful experience I have ever had…to just see them progress and surpass their expectations! (Teacher Interview, February, 2015)

Due to her strong background and comfort with mathematics, Sarah is able to quickly and easily come up with different ways of teaching specific mathematic topics. She provides a specific example of her success in differentiating the instruction of long division, a concept that many students continue to struggle with:

I have actually experienced this with students, initially they did not understand it and they said to me that for years they never understood it and finally based on the strategy that I showed them, they were able to better relate to that and arrive at the solution. They were just over joyed at that. That is one example of success, being able to finally understand what strategy to use to arrive at a solution and become more proficient at it. (Teacher Interview, February, 2015)

Another way that Sarah meets the needs of her students is by creating a classroom environment that facilitates student-learning groups. She aims to develop positive group dynamics to ensure that each student has what they need in order to learn:

I use group work in the classroom to help meet those expectations. I ensure I customize whatever I am doing to the needs of the students. I make sure I tailor my lists accordingly so that even the students who are at level one can still have a
voice because student voice is important. (Teacher Interview, February, 2015)

Sarah’s main teaching goal is to accommodate the full diversity of academic needs that the students bring to the classroom. Looking at her survey results, Sarah’s score was 4.6/6 in December, and by April, her survey results increased to a score of 5.2/6. In the period that this study took place, Sarah continuously worked on her goal and her survey results indicated an improvement for meeting individual student needs (dimension 2).

4.3.2.2 Student Tasks (Dimension 4)

When it comes to the teaching of mathematics, Sarah’s goal is to create effective student tasks that are set in real-life contexts in order to engage students to gain an appreciation for problem solving and mathematics. Sarah says, “my goal is for students to see the need for mathematics learning and application in their daily lives…[for students] to have a better approach to problem solving” (Teacher Interview, February, 2015). According to the results from both surveys, Sarah’s teaching practices regarding student tasks are consistent with current mathematics education thinking. She scored 4.6/6 on the first survey attempt (December) and 5.2/6 on the second attempt (April). Sarah stays current with mathematics education by using students’ diagnostic assessments and the Ministry of Education website to guide the creation of her enrichment tasks, inquiry-based lessons and problem solving activities. She also incorporates cross-strand teaching in her daily routine in order to enhance student tasks:

I try to do cross-strand teaching. I incorporate geometry with measurement; for example, I use the Prometheon Board – technology – to find games that are interactive so that the students can use it to help them solidify [mathematical] concepts previously taught. Also, I use manipulatives, and during our team meetings, we have extensive discussions on the expectations or the objectives [on how to properly use manipulatives], and we just get ideas from each other.
In addition, Sarah enjoys providing students with real-life mathematical experiences. She hopes to take students to the supermarket in order to “see math in action” and be able to tell her students: “when you go to the grocery store, you look at the prices, and the fractions are there, etc.” (Teacher Interview, February, 2015). Sarah uses activities with real-life context to help students understand why mathematics is useful in their daily lives, however, as an educator, Sarah finds this task difficult:

The challenge for me now is to really, explicitly teach them how mathematics will be useful. I like the real life experiences, but they do not see enough of it, and they need to know what goes on behind the manufacture of these great iPods. What about the production, or the behind the scenes? They need to know the involvement of math, the active role that math plays in order for them to use this great device and to have fun with it…Minecraft, is a popular game with the boys, so I am trying to use that to help them understand the value or the importance of mathematics. (Teacher Interview, February, 2015)

4.3.3 Collaboration

As the Grade 6 team leader of the school, Sarah believes in teacher collaboration. Sarah shared in her interview her experience that she had with the other Grade 6 teachers: “We have observed each other actually teaching, and co-teaching within the classrooms!” (Teacher Interview, February 2015). Sarah values these newly implemented strategies, observation and co-teaching, since it helps her learn from others and improve her teaching of mathematics. Additionally, Sarah explains that the teachers gather together as a team to brainstorm new strategies and ideas to improve their teaching of mathematics. They also learn from previous years and go over the school improvement plan making the required changes:

We have several meetings over the course of the year, we make several changes so that it is really customized to meet the needs of our students and parents and the whole school community, staff and admin. (Teacher Interview, February 2015)
4.3.4 Communicating with Parents

When it comes to communicating with parents, Sarah stressed her desire to have parents more involved and actually implement the designed plan for their child:

I wish I could see greater parental involvement…what I need to see though is continuity from the parents…about how their child will progress and what needs to be established or what needs to be put in place for that to happen, I have not seen the continuity of that, so while I will get the support in words, I need to see more in action, I need to see it implemented and followed through but I know they are supportive, I just need to see evidence of it, greater evidence. (Teacher Interview, February 2015)

Parental support is not even at the minimum level that Sarah expects it to be. Sarah is concerned because she has had some cases where parents will only contact her when it comes to insignificant issues. Sarah wants parents to play a more active parental role; she believes that parents need to act as better role models regarding motivation, the pursuit of higher grades, and achievement. Sarah knows that students need to be pushed and motivated, she says:

I believe that is where the parents really need to push forward, to motivate their children more. I have heard too often that students say: “My mom does not care, it does not matter.” To me it matters, I see every child as my own child. (Teacher Interview, February 2015)

She believes that, by increasing parental involvement, students will be more motivated and it “will make a big difference in terms of their academic performance, it will propel them to attain even greater expectations” (Teacher Interview, February 2015).

4.4 Case study 3: Madelyn

4.4.1 Survey Results

Madelyn’s attitude and teaching practices were most consistent with current mathematics education thinking on Dimension 3: learning environments and Dimension
According to the results, the dimension that Madelyn should select as her professional development goal is Dimension 5: constructing knowledge as she acquired a low score of 2.8 out of 6. Table 5 illustrates Madelyn’s score for each dimension (out of 6).

Table 5

<table>
<thead>
<tr>
<th>The Ten Dimensions of Mathematics Education</th>
<th>December</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program Scope and Planning</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2. Meeting Individual Needs</td>
<td>3.6</td>
<td>5.2</td>
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<tr>
<td>3. Learning Environment</td>
<td>5</td>
<td>4.7</td>
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<tr>
<td>4. Student Tasks</td>
<td>3.2</td>
<td>4.4</td>
</tr>
<tr>
<td>5. Constructing Knowledge</td>
<td>2.8</td>
<td>3.6</td>
</tr>
<tr>
<td>6. Communicating with Parents</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>7. Manipulatives and Technology</td>
<td>5</td>
<td>4</td>
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<tr>
<td>8. Students’ Mathematical Communication</td>
<td>4.5</td>
<td>4</td>
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<tr>
<td>9. Assessment</td>
<td>3.3</td>
<td>3.8</td>
</tr>
<tr>
<td>10. Teachers’ Attitude and Comfort with Mathematics</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Overall Score</td>
<td><strong>3.7</strong></td>
<td><strong>4.3</strong></td>
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</table>

In the interview, Madelyn shared that she was working on Dimension 2: meeting individual needs for her personal growth. The reason for this choice is because of the diversity amongst the students in her class; she states: “I cannot teach them as a class, they are so different, everyone is different, I have to be planning for individual students, and they are all at different levels” (Teacher Interview, February 2015).

For her professional development goal, Madelyn said she chose Dimension 7: manipulatives and technology. The reason for her choice was because she does not currently actively engage with technology due to lack of resources and education.

Madelyn said: “I do not have any kind of technology in my class, I have manipulatives but technology is very limited. I selected it to improve upon it and to see if I could get some kind of technology” (Teacher Interview, February 2015).
Madelyn’s overall survey score improved significantly after five months. In December, Madelyn’s average score was 3.7 and in April, her score went up to 4.3. This indicates that Madelyn’s attitudes and practices on the teaching of mathematics have become more consistent with current mathematics education thinking and that she is now more receptive to further changes in her practice. Madelyn improved significantly in Dimension 2: meeting individual needs, Dimension 4: student tasks, Dimension 5: constructing knowledge, Dimension 6: communicating with parents, and Dimension 10: teacher’s attitude and comfort with mathematics. For all the other dimensions, except Dimension 7, the results showed no changes or small insignificant decreases. After the professional development sessions, a significant decrease was seen for Dimension 7: manipulatives and technology.

4.4.2 Professional Learning Goals for Mathematics Teaching

Madelyn finds that students need more time to understand and practice basic mathematics skills. Her goal for the teaching of mathematics is to get her students to work on basic addition, subtraction, multiplication, and division because she believes that a solid foundation in mathematics will give students the opportunity to move on and try rich mathematics tasks. Madelyn expresses her concern of moving forward with concepts when students do not fully understand it:

I think we are going too fast with them because they are not able to grasp the concept before you move on to the next one and I cannot stay in one area for too long because how would I be able to test them compared to the other classes, so I have to move on, I wish I did not have to but it is difficult. (Teacher Interview, February 2015)

Madelyn believes that her goal for mathematics is shared amongst all teachers; in her words: “most of the Grade 6 teachers feel this way, we feel that we are moving too fast,
we need to spend more time and get [the students] to understand the basics before we move on” (Teacher Interview, February 2015). Curriculum expectations and the lack of time to meet these goals of the province leaves Madelyn to think that there is a need for math specialists: “math is a special area, not everyone can teach math, right, so math should be taught by specialists, not just about anyone. I love math but I think that I am not a math specialist” (Teacher Interview, February 2015).

In the following sections, I classify each of Madelyn’s professional learning goals into one of the Ten Dimensions of Mathematics Education.

4.4.2.1 Constructing Knowledge (Dimension 5)

Madelyn believes in the traditional, teacher-centered method of constructing mathematics knowledge. Her primary mathematics-teaching goal is to teach the fundamental skills that students require based on the Number Sense strand from the Ontario Elementary Curriculum; in her words: “My goal is to have the children understanding basic addition, subtraction, multiplication and so on because if they do not have that background, then it is difficult for them to move on” (Teacher Interview, February, 2015). Out of the Ten Dimensions of Mathematics Education, dimension 5 best represents Madelyn’s teaching goal. Madelyn scored lowest in this dimension, constructing knowledge, with a score of 2.8/6 on the Attitudes and Practices to Teaching Math survey in December. This signifies that Madelyn’s current teaching practices do not align with current mathematics education. However, after the professional learning sessions that took place over a five-month period, Madelyn improved her attitude and practices on constructing student knowledge, which was seen by an increase in her survey score to 3.6/6.
Some of Madelyn’s views on how to construct students’ mathematical knowledge aligned with current mathematics education thinking. For example, instead of focusing on the correctness or wrongness of students’ work, Madelyn focuses on what the students may or may not have understood. She explains in detail:

There are so many different ways you can solve a problem. In my class, for example, if we are doing a problem, I let my class know there is not only one way of doing it, there are so many different ways and we explore the different ways. It is not about right or a wrong, it is about the way you figure it out and the way you think that you can solve the problem. (Teacher Interview, February, 2015)

Madelyn’s traditional view on the teaching of mathematics makes her less receptive to further changes in her practice; however, professional learning has helped her understand the need for a constructivist approach in the mathematics classroom.

4.4.2.2 Meeting Individual Needs (Dimension 2)

One of Madelyn’s professional learning goals is to work on Dimension 2, meeting the individual needs of her students. In order to achieve her goal, Madelyn invites the students in her class to stay after school or at lunch for extra help. As a passionate educator, she aims to work with each of her students on a one-on-one setting as often as possible. Madelyn shares that she works together with her students to help them further understand any difficult mathematical concept. She says: “I sit with my students and ask ‘where do you think you went wrong with this?’ We sit and work together, to help them understand areas that they are weak in” (Teacher Interview, February, 2015). Madelyn’s dedication to complete her goal resulted in major improvements according to her survey results. She started off with a score of 3.6/6 on the December survey and then, increased her score to 5.2/6 on the April survey.
Nevertheless, Madelyn struggles to cover all of the strands from the curriculum and simultaneously meet all of the individual needs of her students. Her biggest professional challenge is meeting the expectations of an educator, while at the same time, guaranteeing that all her students become proficient at each mathematics concept covered:

It is kind of frustrating because if you have to follow the curriculum, then the children are not learning all the strands that they need to learn. I think we are short changing them. If we have to follow the curriculum and try to cover all that there is, it is difficult, it is impossible, because I have 9 Individual Education Plans (IEP) in my class. (Teacher Interview, February, 2015)

Having a classroom where half of her students have individual education plans makes it challenging for Madelyn as a teacher, but with the help of her colleagues and the skills obtained from professional development, Madelyn is working towards her goal of meeting every student’s individual need.

4.4.3 Collaboration

Madelyn finds co-planning with other teachers a valuable experience. Madelyn explains that the teachers meet often to discuss the areas that they find challenging to teach and they share different ideas as well as their personal teaching stories in order to help one another. She also spoke about how every so often the Grade 6 teachers will do co-teaching and learn from one another in that manner.

4.4.4 Communicating with Parents

Madelyn is frustrated with the lack of supportive parents in the school. After attending two parent-teacher interview sessions, she reports that she has not even had the opportunity to meet half the parents. Even though she tries to initiate contact with parents, she is unable to reach them. Sadly she says: “I really do not know my parents,
and the ones that I see are not the ones who I really want to see” (Teacher Interview, February 2015). When she does manage to communicate with parents, she finds that most are not informed or do not understand what is happening at school. Madelyn provides one example:

I saw a parent on Tuesday and I asked her what was her impression on her kid’s report? She said: "Well [the report] is okay because when he was in elementary school it was the same thing he got because they say he has something that is called an IEP.” I asked: “Do you understand what that is?” and she said, “No,” she doesn’t, so what can you do? (Teacher Interview, February 2015)

Madelyn lost hope in parental support because of the lack of parent communication and their inability to help their children.

4.5 Case study 4: Lindsay

4.5.1 Survey Results

Table 6 shows each of Lindsay’s score for all the dimensions (out of 6).

<table>
<thead>
<tr>
<th>The Ten Dimensions of Mathematics Education</th>
<th>December</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program Scope and Planning</td>
<td>4.7</td>
<td>4.7</td>
</tr>
<tr>
<td>2. Meeting Individual Needs</td>
<td>5.2</td>
<td>5.6</td>
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<tr>
<td>3. Learning Environment</td>
<td>6</td>
<td>6</td>
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<tr>
<td>4. Student Tasks</td>
<td>5.2</td>
<td>5.6</td>
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<tr>
<td>5. Constructing Knowledge</td>
<td>5.6</td>
<td>5.6</td>
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<tr>
<td>6. Communicating with Parents</td>
<td>5</td>
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<tr>
<td>7. Manipulatives and Technology</td>
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<td>8. Students’ Mathematical Communication</td>
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<tr>
<td>9. Assessment</td>
<td>5</td>
<td>4.8</td>
</tr>
<tr>
<td>10. Teachers’ Attitude and Comfort with Mathematics</td>
<td>5</td>
<td>5.2</td>
</tr>
<tr>
<td>Overall Score</td>
<td><strong>5.3</strong></td>
<td><strong>5.4</strong></td>
</tr>
</tbody>
</table>

Lindsay scored a perfect score on Dimension 3: learning environment, which suggests that she is consistent with current mathematics education thinking and is open for future changes in her practice. Her lowest score was 4.7 out of 6 on Dimension 1:
program scope and planning, which indicates that this should be her focus for her professional development goals.

When asked which Dimension Lindsay had chosen for her personal growth, she answered that she had chosen Dimension 2: meeting individual needs. Lindsay explains that the reason for her choice was due to her previous experiences:

I think it comes because of my Spec Ed background and diversifying my lessons and understanding that I have different learners at different levels at all times in my class. It does not matter if they go to resource or if they do not go to resource, they need to be engaged in my class. Meeting individual needs is very, very important to me. Not looking necessarily at the whole class but looking at each child. (Teacher Interview, February 2015)

Lindsay also chose Dimension 3: learning environment as part of her professional development goals. She believes that the space where students learn is essential to student success:

If the kids are not happy in their learning environment, if they are not respected, they are not learning. To me, math is a part of a whole so...if they do not like me as a teacher (which well some people say well they do not have to like me, well they do not have to like me outside the school but they have to like me in the class) then the moment I say good morning, they have already shut down. For me the learning environment and meeting individual goals are really important. (Teacher Interview, February 2015)

Lindsay’s overall survey results increased slightly from December to April. Lindsay scored 5.3 on her first time and 5.4 the second time around. High scores on both surveys indicate that Lindsay’s practices and attitude towards the teaching of mathematics are consistent with current mathematics education thinking. Although, Lindsay’s score for each of the dimensions were already high, she did improve slightly in Dimension 2: meeting individual needs, Dimension 4: student tasks, and Dimension 6: communicating with parents.
4.5.2 Professional Learning Goals for Mathematics Teaching

Lindsay believes that teaching is her calling. Lindsay started teaching in her late career and is extremely passionate about inspiring her students to love learning. Lindsay describes her most important teaching goal:

I want to impart into kids that education is something they really need if they want to be successful. Just to see kids again fall in love with learning, whether it is in an educational format, in a school. A lot of these kids, you know, the kids that come to this school, cannot afford to go to university and do not have the background for school that is encouraged at home, but if I can get them to fall in love with learning that to me is what I want to accomplish. (Teacher Interview, February 2015)

When it comes to mathematics, Lindsay has her own personal goals of re-learning the content. Lindsay did not enjoy and truly disliked secondary mathematics when she was in high school due to her teachers’ attitudes towards math. Now, as a teacher herself and understanding the importance that mathematics has on our world, she shares her past experiences with math and she is very careful about not having her student absolutely hate mathematics. Lindsay often tells her students: “do not drop math, because it is applied to so many areas of our lives and you do not know what you want to do at the end and it might mean that you might need the math” (Teacher Interview, February 2015). Lindsay learns best through real-world applications, so she often uses “cooking, or going to the store” to explain mathematical concepts in a way that students are able relate to and can easily understand.

In order to further help her students, Lindsay’s professional learning goal is to keep learning new mathematic strategies: “My goal in math is to really learn math myself, that was my goal. I took math [Additional Qualification courses]…I learned a lot in my math AQ actually” (Teacher Interview, February 2015). However, although
Lindsay is continuously trying to improve her own skills as a teacher, she believes that there should be designated mathematics teachers: “I am talking about a person who loves math, has learned how to teach and share math…” (Teacher Interview, February 2015). These mathematics specialists should be passionate and have a strong mathematics background.

In the following sections, Lindsay’s professional learning goals are arranged into one of the Ten Dimensions of Mathematics Education.

4.5.2.1 Learning Environment (Dimension 3)

Lindsay’s most important teaching goal is to create a classroom environment that fosters a love of learning. Her goal is represented by dimension 3, the learning environment. Her teaching practices are current with mathematics education thinking since she had perfect scores in dimension 3 on both of the Attitudes and Practices to Teaching Math surveys. Lindsay feels that having a positive learning environment is important and allows her students to feel comfortable, safe, and engaged:

If the kids are not happy in their learning environment they are not learning. If they are not happy, if they are not respected, if they do not like me as a teacher, the moment I say good morning, they have already shut down. (Teacher Interview, February, 2015)

This goal is Lindsay’s priority and she is always looking for ways to help her students succeed:

I do a lot of character building. Every month I go through all the character development traits and we spend time talking about social justice because if not the kids are not going to be able to work together. I talk about respect, communication, sharing, honesty, and collaboration. [I also talk about] problem solving, not just for math, but learning how to work together. This helps with math by creating a safe environment in my classroom. (Teacher Interview, February, 2015)
According to the findings, Lindsay is consistently and successfully working on her goal of creating an open, rewarding, and responsive classroom environment.

**4.5.2.2 Teacher’s Attitude and Comfort with Mathematics (Dimension 10)**

Lindsay’s professional learning goal is to review and re-learn all of the mathematics concepts covered in the Grade 6 curriculum. This personal growth goal, desiring to feel comfortable teaching mathematics, is represented by dimension 5. Although her results from the survey (a score of 5/6 and 5.2/6) show that Lindsay’s attitudes are current with mathematics education thinking, Lindsay believes that there is still a lot of room for improvement. She explains that her goal is to learn mathematics herself and she shares the process she took in order to complete that goal: “I took the Math Part 1 [course], and I never thought I would say this but I am thinking about taking Part 2 as my specialist” (Teacher Interview, February, 2015). Lindsay cannot believe how much she has learnt from the additional professional development and is shocked to hear herself say that she is thinking about continuing to take more mathematics professional learning courses.

Lindsay does not have a strong mathematical background. During her schooling years, she dropped the subject as fast as she could once she finished her grade 11 course. When Lindsay started teaching the elementary grades, her biggest fear was to teach mathematics. In the beginning of her teaching career she always doubted her mathematics abilities: “I do not have extensive math knowledge and I need to know what my kids are thinking and where they are making their mistakes…if I cannot do that on the drop of a hat…how can I help them?” (Teacher Interview, February, 2015). Lindsay believes that a
teacher that holds a mathematics degree is able to understand where and how students make mistakes and are better equipped at helping them figure out the answers. Lindsay’s other challenge is: “If I do not have the foundation knowledge, then I am always struggling as a teacher. So how can I bring excitement to the subject?” (Teacher Interview, February, 2015). She believes that in order to successfully teach mathematics, the educator needs to be passionate about the subject and about sharing their learning strategies. However, despite weak mathematics content knowledge, Lindsay finds that her past experiences have helped her better understand the students’ challenges: “I really empathized with them and I really understand the struggle” (Teacher Interview, February, 2015).

4.5.2.3 Meeting Individual Needs (Dimension 2)

Another one of Lindsay’s goals for the teaching of mathematics is to meet the individual needs of her students. Lindsay has a Special Education background and understands the value in differentiating her lesson plans for the students in her classroom. She explains that she has learners in her class that are at various different levels, and says: “It does not matter if they go to resource or not…they need to be engaged in my class. Meeting individual means is very important to me. Not looking necessarily at the whole class but looking at each child” (Teacher Interview, February, 2015). As a dedicated educator, Lindsay is constantly working on dimension 2 and this is demonstrated through her high results on both surveys, a 5.2/6 score in December and 5.6/6 score in April.

4.5.3 Collaboration

Lindsay describes that she has never seen so much collaboration within a school.
After being in Bruce Peninsula Middle School and working with the other Grade 6 teachers, Lindsay admires how teachers and administration can work so well together to benefit the students in the school. Lindsay is pleased to see how strong collaboration among teachers is transmissible to students:

So when we talk to the kids about working together, sharing their learning, combining their efforts, they see that in the teachers and so I think that creates an environment of collaboration. I think that because we know that learning happens so much from sharing – what we know and what we do not know – I think that is such a strong thing here, a strong tool in this school as far as advancing student learning. (Teacher Interview, February 2015)

Lindsay comments that there is also a collaborative effort when developing the school improvement plan (SIP). She explains that they take into consideration the needs of the community and the students, questioning: “Where are we going to grow? How are we going to grow, and how are we going to implement that into the school? And how can we do that together?” (Teacher Interview, February 2015). On the contrary, Lindsay thinks that collaboration among the parents and the community is absent.

4.5.4 Communicating with Parents

Lindsay’s experience with parents in this school has led her to believe that there are two types of parents: those who are very interested in their child’s education and those who are simply not because of various reasons. Due to the socioeconomic demographic of Bruce Peninsula Middle School, Lindsay believes that they face more challenges when it comes to parental support. For example some of her students’ parents have limited formal education and though willing to help, they are unable to do so:

They have challenges, you can see that, they have socioeconomic challenges, they have immigration challenges, they have educational challenges…other parents, they do not know math themselves so they do not encourage it, so I think it all has to do with where the parents are at. (Teacher Interview, February 2015)
Additionally, Lindsay believes that the manner in which education is taught makes it challenging for parents to engage, making it difficult for them to help their children. She says: “We have changed the vocabulary where parents cannot understand it. We changed the system and we did not bring in the parents along and I think it is a shame” (Teacher Interview, February 2015).

4.6 Summary

The four educators shared their personal and professional goals for teaching mathematics and the factors that affected them to set these goals.

Jacob’s professional goal is to move away from traditional teaching and use reform-based mathematical strategies while surpassing curriculum expectations. His personal goal is to pursue an administration leadership role in the school. Sarah’s goal is to make math meaningful and eliminate the fear or negative attitudes that students have towards mathematics. Her overall teaching goal is to meet students’ individual needs and focus on teaching life skills rather than exclusively academics. Madelyn’s lack of time to meet provincial expectations, leaving students without a grasp of basic numeracy skills, led her to create her goal of guaranteeing that the students have a solid foundation in mathematics. Lindsay’s personal goal is to re-learn mathematics content in order to be better prepared for students’ questions. Her general teaching goal is to have her students fall in love with learning. Both Madelyn and Lindsay believe that mathematics specialists should be teaching students mathematics in place of core teachers.

After taking a survey to measure which dimension they should focus on for professional development, three of the four participant teachers identified Dimension 5: constructing knowledge. The dimension that the teachers were most consistent with
current mathematical education thinking varied amongst all the teachers, however the
most prominent answers were dimension 7: manipulatives and technology, dimension 6:
communicating with parents, and dimension 3: learning environment. When interviewed,
all of the teachers reported to be working on dimension 2: meeting individual needs as
well as another dimension that varied throughout. After five-months of teaching and
attending four professional learning sessions, all the teachers improved their overall score
to align with reform-based mathematical thinking. The dimensions that had the most
improvement were dimension 2: meeting individual needs, dimension 4: student tasks,
and dimension 6: communicating with parents.

All the teachers in this study agree that collaboration plays an important role in
constructing their goals and improving their teaching of mathematics. They concur that
sharing their teaching strategies, co-planning, and co-teaching helps them advance
student learning. Moreover, all of the participating teachers shared the same views when
it came to parental involvement. They all agreed that the lack of parental support was an
obstacle for student progress. They understood, however, that there were two different
types of parents (those who were interested in their child’s education and those who were
not) and due to the demographics of the school some parents faced more challenges than
others since they may have had limited formal education and were unable to help.
Nonetheless, the teachers wished that parents would play a more active role in their
child’s education in order to make a difference in their academic performance.
Chapter Five: Discussion and Interpretation of Findings

5.1 Introduction

This chapter revisits the research questions posed in Chapter One and explores how four individual case studies offer answers to these questions. The findings are linked to the current literature reviewed in Chapter Two and major findings are outlined. Recommendations for teacher professional development will also be presented. Finally, areas for further research regarding teacher goal setting will be suggested.

5.2 The Research Questions

This thesis focused on the questions posed in Chapter One, which were:

1. What is the relationship between identifying in which dimensions each teacher scores higher or lower on and the goals they set for themselves and their students?

2. How do elementary school teachers’ beliefs and attitudes towards mathematics influence their professional mathematics teaching goals?

3. What are some of the possible influences that contribute to how teachers set and identify their mathematics teaching goals?

I will examine each research question by doing a cross-case analysis on the findings of Jacob, Sarah, Madelyn and Lindsay’s individual case study.

5.3 Discussion of Each Research Question

5.3.1 What is the relationship between identifying in which dimensions each teacher scores higher or lower on and the goals they set for themselves and their students?

The main purpose of this research study was to identify and analyze the relationship between teachers’ beliefs surrounding mathematics and their teaching goals.
In order to do so, teachers measured their current attitudes and practices towards mathematics and were given an overall score as well as an average score corresponding to each one of the Ten Dimensions of Mathematics Education (McDougall, 2004). These ten strands are outlined and summarized in Chapter Two. The Ten Dimensions of Mathematics Education is a framework that helps teachers set specific goals by focusing in on one dimension at a time for personal growth. Setting specific expectations is part of the effective goal setting process that is also demonstrated in other goal setting methods such as 4C F goals (Locke & Latham, 2002), SMART goals (O’Neill, 2000), and POWER goals (Day & Tossey, 2011). Each individual case study was analyzed to understand the correlation between the results from the Attitudes and Practices to Teaching Mathematics survey and the specific professional development goals chosen.

To begin, one of Jacob’s teaching goals is to have all his students work on open-ended questions and rich tasks and he wants his students to become self-regulated learners. His goal aligns with the fourth dimension, student tasks, that encourage teachers to have a balance of mathematical tasks in the classroom. Jacob’s other teaching goal is scaffolding knowledge for students and surpassing what the Ministry of Education expects for their grade level. This goal falls under constructing knowledge, dimension five, where teachers use a constructivist approach and effective questioning to assist their students in gaining new knowledge. Jacob also mentioned that he had selected dimension two, meeting individual needs, as his goal for personal growth. When attempting the first Attitudes and Practices to Teaching Mathematics survey, he scored the lowest on constructing knowledge, dimension five and the highest on dimension six, communicating with parents, and dimension seven, manipulatives and technology. In
Jacob’s case, the results show that he set his teaching goals according to his lowest score from the Attitudes and Practices to Teaching Math survey.

Next, Sarah’s teaching goal is to find the most appropriate learning path for each of her students according to their learning style. In essence, she is looking to meet each student’s individual need, which is dimension two from the framework, the Ten Dimensions of Mathematics Education. Given the fact that Sarah consistently strives to make mathematics meaningful for her students, her subsequent teaching goal is to create engaging rich problem solving activities and real world opportunities for her students. We see here that her goals are clearly representational of fundamental elements from dimension four, student tasks.

When asked which dimension she had chosen as her personal growth goal, she mentioned meeting individual needs, dimension 2, and assessment, dimension 9. Results from the first Attitudes and Practices to Teaching Math survey show low scores for dimension five, constructing knowledge and high scores for dimensions one, six, seven and ten (See Appendix A). Sarah’s case study failed to highlight a direct link between her scores acquired from the survey and the goals she set for herself. However, dimension two and five are closely related to one another, which revealed that similar to Jacob’s case study, Sarah also set her goals according to her lowest score on the Attitudes and Practices to Teaching Math survey.

Madelyn’s teaching goal lies with a desire for all her students to have a solid mathematics foundation. She believes that, if students can grasp basic knowledge skills, then they will be well equipped to tackle rich learning tasks. Madelyn’s teaching goal lies within the fifth dimension, constructing knowledge. She also mentioned that she was
working on meeting individual needs, dimension two, and improving her technology skills, dimension seven, when asked to recall her personal growth goal that she had chosen.

Madelyn’s highest scores on the Attitudes and Practices to Teaching Math survey were dimension three, learning environment, and dimension seven, manipulatives and technology. Her lowest score was dimension five, constructing knowledge. Madelyn’s case study led to two conclusions. First, similar to Jacob and Sarah, Madelyn chose one of her goals according to the dimension that needed most improvement. Secondly, one of her goals that she had already set for herself prior to the study, resulted in a high score on the survey results, which is represented by dimension seven, manipulatives and technology. This signifies that high scores on the survey can emerge from goals that teachers are currently working on.

Lindsay wants to foster an inclusive and safe environment where her students are able to learn and share ideas. Her teaching goal is to have her students fall in love with learning. Lindsay’s teaching goal fits into the learning environment category, dimension three. Her other professional goal is to work on her own mathematical capabilities. Lindsay wants to relearn certain math concepts and be more comfortable teaching them, which aligns with dimension ten, teacher’s attitude and comfort with mathematics.

When asked about her personal growth goals, Lindsay explained that she was working on meeting individual needs, dimension two, and the learning environment, dimension three. Lindsay’s results for each of the dimensions were high with the highest score being the learning environment, dimension three, and the lowest score being program scope and planning, dimension one. Similar to Madelyn’s second conclusion,
Lindsay’s case study shows that high results emerged from elements that she had already chosen as goals prior to the study.

In conclusion, two inferences were made after analyzing the results from each of the teachers’ case studies. On one hand, after taking the Attitudes and Practices to Teaching Mathematics survey, teachers used their lowest scores to create their professional learning goals and had specific objectives that they worked on throughout the year. On the other hand, teachers who had already set specific goals for themselves prior to taking the Attitudes and Practices to Teaching Mathematics survey received high scores in those areas. For the most part, three of the four participant teachers chose to work on their weakest dimension. The findings from the four case studies correspond with the purpose of using the Ten Dimensions of Mathematics Education (McDougall, 2004).

5.3.1.1 Relationship amongst the Dimensions

The findings revealed a relationship between dimensions 2, 3, 4, and 5. The first observation is that all of the teacher participants were focusing on dimension two, meeting individual needs, as an area for professional improvement. Secondly, three of the four participants scored lowest on dimension five, constructing knowledge. The relationship between these two dimensions can be seen through the goal setting process. The three teachers (Jacob, Sarah, and Madelyn) who scored low on dimension 5 all had dimension 2 as one of their professional learning goals. Constructing knowledge depends heavily on students’ prior knowledge and current needs. Meeting individual needs requires teachers to tailor their instruction to the current needs of their students. These two dimensions, constructing knowledge (5) and meeting individual needs (2), depend on
one another and thus a strong relationship can be seen among them. This conclusion correlates with McDougall’s (2004) findings.

The second observation is that Jacob and Madelyn also focused on dimension 4 and Lindsay also focused on dimension 3 for their teaching goals. Therefore the common goals among teachers were in dimensions 2, 3, 4, and 5. These four dimensions have one specific attribute in common: they are all student centered. Among all of the ten dimensions, these four dimensions are the ones that directly impact student learning and achievement. Therefore, the results show that the teachers chose goals in areas that focused on student learning and improving students’ learning environments. These goals have a mastery orientation, which, in turn, serve to affect instructional practices, resulting in improved student learning (Schunk, Pintrich, & Meece, 2008).

5.3.2 How do elementary school teachers’ beliefs and attitudes towards mathematics influence their professional mathematics teaching goals?

Teachers’ attitudes and beliefs towards the teaching of mathematics were investigated through a survey and semi-structured interviews. The findings revealed that teachers’ beliefs influenced which dimension they were most or least aligned with current mathematics education thinking. The most prominent finding was that teachers believed in traditional mathematics instruction, and most scored lowest in dimension 5, constructing knowledge. In the interviews, Jacob and Sarah admitted that they had learnt in traditional environments, and Madelyn shared her views of getting students to learn the basic mathematics skills in a more traditional manner before jumping into critical thinking opportunities. Jacob, Sarah, and Madelyn scored lowest on dimension 5,
constructing knowledge, which implied that this is an area where all of them are not current with mathematics education thinking and thus should be an area for improvement.

For the three of the four participants of this study who held traditional views, there was no surprise that their beliefs resulted in a low score on dimension 5. Therefore, the first findings demonstrated that, if the teachers’ beliefs were opposite to the current mathematics practices, then they received low scores on the surveys, suggesting that they should choose that dimension for their professional learning goal.

The second finding showed that the teachers’ beliefs positively influenced their mathematics teaching practices, which was confirmed by receiving high scores on the survey, which implied that teachers were current with mathematics education thinking in those areas. However, teachers did not choose the dimensions where their beliefs aligned with current mathematics thinking as their teaching goals.

Jacob’s primary belief is providing leadership for his students. He is often taking on the role of leadership at Bruce Peninsula Middle School and in his near future, he aspires to be a principal of an elementary school. When taking the Attitudes and Practices to Teaching Mathematics survey, one of Jacob’s highest scores was dimension six, communicating with parents. As an educator, taking on the role of a leader requires good parent communication skills. Therefore, a relationship exists between his principal teaching belief and his high score on Dimension 6.

Sarah is constantly striving to eliminate the fear of mathematics in students. With a strong background in mathematics and science, Sarah believes in getting her students to become critical thinkers. Her attitude and comfort with mathematics is reflected
positively in her results since one of her highest score was dimension ten, teachers’ attitude and comfort with mathematics.

Madelyn’s passion for teaching comes from her past elementary teachers who taught her to foster a safe and welcoming learning environment for her students. Madelyn believes in teaching her students life lessons, more than simply academics. Her beliefs are reflected in her survey scores since dimension three, the learning environment, was one of her highest scores.

Lindsay believes in getting her students to fall in love with learning and value education. Lindsay sees teaching as her calling and wishes to create an environment where students feel comfortable to share their ideas. Lindsay’s beliefs greatly influenced her results as she received a perfect score in dimension three, the learning environment.

The close examination of teachers’ beliefs and attitudes towards mathematics teaching revealed two significant conclusions. Firstly, when teachers were found to hold traditional views in relation to teaching mathematics, they also scored the lowest on constructing knowledge (Dimension 5) indicating that this is an area for improvement. Secondly, any prior teaching beliefs influenced their teaching practices. Teachers’ high scores appeared to align with what they believed was the most important aspect of teaching.

5.3.3 What are some of the possible influences that contribute to how teachers set and identify their mathematics teaching goals?

5.3.3.1 Professional Development

The teachers from this study participated in a series of research based professional development sessions that focused on student learning, used the Ten Dimensions of
Mathematics Education (McDougall, 2004) as a self-assessment and goal setting tool, and used exit cards to incorporate teachers’ needs into the upcoming sessions. All of these components are recognized as characteristics of a successful teacher development program as recommended by the Ontario Ministry of Education (2007). After undergoing a series of sessions, overall improvements were seen in all of the four case studies.

The teacher whose mathematics teaching attitudes and practices improved the most after the professional learning sessions that took place over a five-month period was Madelyn. She improved significantly on meeting individual needs (Dimension 2) and constructing knowledge (Dimension 5), which were part of her professional goals. This supports the findings from Goldsmith, Doerr, and Lewis’ (2014) literature review that described how another 36 studies also showed the impact of professional learning on teaching beliefs.

Madelyn had also chosen dimension seven, manipulatives and technology, as one of her teaching goals. The professional learning coordinating team acknowledged that teachers learn differently and following the Dynamic Integrated Approach, responded to the teachers’ individual needs by incorporating a technology session as part of the process (Antoniou & Kyriakides, 2013). The session taught teachers how to use a variety of computer software to teach grade six level mathematics. In Madelyn’s case, however, a significant decrease was shown in her results. This demonstrates that, after undergoing professional training, Madelyn realized that her aptitudes did not align with current mathematics education standards and that she had a lot more to learn.

Similar to Madelyn, professional development also positively affected Jacob’s results. Jacob’s overall score increased. Lindsay and Sarah were the most consistent with
current mathematics education thinking since their scores were high, close to perfect. Both of these teachers expressed the importance of professional development and still saw slight increases in their results from December to April of this study.

In conclusion, the professional learning sessions that the teachers participated in gave them the opportunity to clarify their beliefs as mathematics educators and self-reflect about their teaching practices. As such, these changes were positively reflected through the teachers’ survey results, which showed an overall improvement in their scores, indicating that professional learning sessions can positively influence teachers’ instructional goals.

5.3.3.2 Collaboration

Teacher collaboration is an important factor that affects the goal setting process as well as which goals are selected for personal growth. Steering away from the traditional approach, a new collaborative approach, co-teaching, was implemented in Bruce Peninsula Middle School. Co-teaching, where two teachers worked together to deliver the lessons and assess instruction, was of most value to all of the Grade 6 teachers. Observing other teachers and sharing the teaching process helped Sarah improve her teaching of mathematics. Likewise, Madelyn was able to take other teacher’s ideas and modify them to use them in her classroom. Similar to Owen’s (2013) study, the co-teaching process led teachers to create more creative tasks and materials.

Prior to co-teaching, Madelyn mentioned that teachers collaboratively planned the lessons, student tasks, and activities. During the planning process, the teachers developed the general goals of each lesson while keeping in mind different ways to meet the academic or behavioral needs of individual students. Co-constructing the students’
curriculum was a strategy that the Grade 6 teachers used to help improve student achievement. This correlates with Moolenaar et al.'s (2012) findings that planning collective goals is positively associated with increased student achievement.

Sarah, the Grade 6 team leader, sees the importance of having grade level meetings for teachers as well as how it can benefit the students. Since the school gave the teachers opportunities to observe each other’s teaching styles and an opportunity to co-teach, Sarah values the reflection period and discussion among her colleagues to summarize how to improve the teaching of mathematics. In agreement, Jacob believes that the most important part of the meetings is the time given to share each teacher’s different strategies towards mathematics. Thus, similar to Ronfeldt et. al (2015) findings, the domain that was most helpful for teachers was co-constructing instructional strategies and materials.

As Madelyn mentioned, teachers also discuss other topics in the grade level meetings, such as sharing challenging scenarios that arose in their own classrooms. Together, they come up with various strategies on how to solve the problem; how to motivate difficult students, what to do for the next time something similar occurs, or how to deal with behavioral issues. Collective brainstorming for difficult scenarios motivated the teachers in believing in themselves, thus increasing their self-efficacy (Moolenaar, Sleegers, & Daly, 2012).

As a new member of the Bruce Peninsula Middle School team, Lindsay admires how the Grade 6 teachers are supportive of one another and are always sharing their resources and materials. The collaborative environment that exists in their school parallel’s Forte and Fores’ (2014) school atmosphere. Strong teacher relationships are the
core of the collaboration process and helps colleagues’ work feel acknowledged. Lindsay works together with the Grade 6 team to develop the school improvement plan that considers the needs of the students and the community.

The students also benefit from this collaborative atmosphere in two levels. One, students receive better instruction, improved student tasks and benefit from new experiences, which leads to higher achievement (Forte & Fores, 2014). Secondly, students mimic teacher behavior, which results in students collaborating with classmates in their learning process, and as a result helps them improve academically.

5.3.3.3 Parental Involvement

All of the teacher participants mentioned that there was a lack of communication between the parents and themselves. Jacob, Sarah, Madelyn and Lindsay felt that lack of parental involvement was an obstacle for student progress and student success; they believe that parental involvement is needed in order to increase student motivation, which would result in higher achievement. In one of the case studies, Sarah also expressed the need for parents to act as role models for their children and have continuity from parents. This supports the findings of Jones and White (2000) as well as Fan and Williams (2010).

The findings from the case study of Madelyn showed that parents lack understanding in what their children do at school, which led to unsupportive parents. This finding supports Fan and Williams (2010) study which explained that early teacher-initiated communication was needed in order to receive support from parents to engage and motivate the students.

Lindsay discussed the reasoning behind the lack of parental involvement. She explained that some parents in the community find it difficult to engage with the school
and related activities due to lack of education, economical challenges, teacher jargon and immigration related challenges. This supports the findings of Flynn (2007) who discussed that the obstacles for parent communication were parents’ negative experience with school, language barriers, teacher jargon, devaluing education and lack of education. Research by Jones and White (2000) also found that parents’ education level and school experiences affected student learning.

5.4 Major Findings

This thesis examined the case study of four Grade 6 teachers and how their beliefs influenced how they set their mathematics teaching goals. The study showed how the Ten Dimensions of Mathematics Education (McDougall, 2004) assisted teachers in creating these goals. Other influencing factors, such as professional development, collaboration, and parental involvement, were also addressed in how they altered the teachers’ goal setting process.

The major findings of the case studies can be summarized as follows:

1. Teachers chose teaching goals that corresponded to the dimensions that had low scores from the Attitudes and Practices to Teaching Math survey. The Ten Dimensions of Mathematics Education framework helped teachers focus on their weakest area, which allowed them to set specific objectives for their professional growth.

2. Teachers’ prior knowledge and experience with the elements in each dimension affect the Attitudes and Practices to Teaching Math survey scores, which determines the dimensions in which a teacher is most consistent with current mathematics education thinking.
3. Some teachers believe in traditional mathematics instruction, and as a result, they scored lowest on dimension 5, constructing knowledge, which suggests that teachers are not currently aligned with mathematics education thinking in this domain.

4. Teachers’ goals primarily focused on dimensions 2, 3, 4, and 5, which are all dimensions that directly focus on student learning.

5. Effective professional development can have an influence on teachers’ attitude towards mathematics and the goals they set for themselves, as seen with all of the teacher participants from this study who became more consistent with current mathematics education thinking after taking professional learning sessions.

6. Due to the lack of parental involvement within the school, the teachers are required to take on the parental role. This lack of support and communication affects the teachers’ goals by concentrating on dimensions that focus mostly on student needs.

5.5 Suggestions for Teacher Professional Learning Sessions

The contributing factors that affect the teacher goal setting process are of concern, so I propose an addition to the teacher change model (Ross & Bruce, 2007). I include teacher collaboration and parental input as elements influencing teacher goal setting and I incorporate the framework of Ten Dimensions of Mathematics Education (McDougall, 2004) as part of the goal setting process (see Figure 2).
The findings arising from this study and from the literature review (Forte & Fores, 2014; Johnston et al., 2007; Ministry of Education, 2010; Moolenaar et al., 2012; Owen, 2013; Ronfeldt et al., 2015) suggest that teacher collaboration is an integral part of teachers’ goal setting process and instructional practice. As explained in the findings, co-teaching is an effective method used for instruction and co-planning is a key contributor to setting teacher goals, therefore teacher collaboration affects these two components of the teacher change model. Similarly, according to the results from Fan and Williams’ (2010) study and conclusions from this study, parental input influences teacher goal setting. This study’s findings revealed that there was lack of teacher-parent communication and lack of parental involvement in the school. Consequently, this led to
minimal assistance regarding students’ individual needs, which altered teachers’ instructional goals to meet the needs of their students. These outcomes propose that parental input can directly affect teacher goal setting and should be part of the teacher change model.

Golsmith, Doerr, and Lewis’ (2014) literature review revealed that existing professional development does not focus on teacher learning but rather it focuses on the effectiveness of each program. Contrary to those findings, this study used the Ten Dimensions of Mathematics Education (McDougall, 2004) framework in order to focus on teachers’ specific needs. This framework allowed teachers to identify and implement specific goals for professional improvement. In this study, the Ten Dimensions framework was used as a goal-setting model and thus should become part of the goal setting process for teachers in the teacher change model.

A cyclical relationship exists between elementary teachers’ beliefs, teachers’ instructional practice of mathematics, and student achievement in mathematics (Ross & Bruce, 2007). As suggested by the National Council of Teachers of Mathematics (2010), collaboration between researchers and practitioners is needed in order to create successful teacher changes that focus on effective teaching and learning opportunities (Arbaugh et al., 2010). If the mathematics education research community is to effectively respond to practitioners regarding professional development, a focus should be placed on teacher goal setting by applying the refined teacher change model (Figure 2, original created by Ross & Bruce, 2007) to professional development sessions in order to create more confident teachers and positively affect the cyclical relationship.
5.6 Recommendations for Further Research

This study shows the goal setting process of four elementary school teachers. The teachers underwent four professional development sessions that encompassed goal-setting strategies. Through this process, the teachers were able to pinpoint the dimensions that needed improvement and were able to create educated goals. Teachers’ beliefs and attitudes towards the teaching of mathematics were examined to see how it impacted their teaching goals. After the four professional learning sessions, all of the teachers showed improvements further aligning with current mathematics education thinking. A longitudinal research is needed to study the change in teacher attitudes, teaching practices, and teaching goals.

With the push for differentiated instruction for students, another area of additional research could be whether or not differentiated instruction should be provided for teachers. Areas of improvement should be selected based on teachers’ level and years of experience. Hence, does the dimensions from the Ten Dimensions of Mathematics Education vary based on different levels of a teacher’s career? Should teaching goals be different for novice teachers than those of veteran teachers?

In this research study, the teacher participants’ mathematics background and abilities varied greatly and it only focused on how teachers’ attitudes towards the teaching of mathematics impacted their teaching goals. However, do teachers’ comfort with mathematics affect teachers’ professional learning goals? Are there any differences in teachers’ goals for teachers who have a mathematics university degree versus teachers who do not?
The study examined four Grade 6 teachers. Although the four case studies were models to show which dimensions teachers were most or least aligned with current mathematics thinking, they were just four cases. Thus, the findings are specific and particular to only this study, and so more research and evidence is needed in order to generalize the conclusions. A future study involving more elementary teachers would provide more tangible results on which dimensions elementary teachers needed to focus on for personal growth.

Bruce Peninsula Middle School is located in an urban area and has socioeconomic challenges. I wonder if the findings would be different at different geographic school locations or schools with no socioeconomic challenges. Could similar teacher goals be present in different circumstances? Does the school environment influence mathematics-teaching goals? Similarly, I wonder if findings from different grade levels or from the high school level would be different. Do teachers focus on different dimensions with younger student than they do with older students? Are teaching goals in mathematics similar across all age groups?

This study was an excellent example of how to use the Ten Dimensions of Mathematics Education as a goal-setting method as part of professional development sessions for elementary teachers in order to effectively change their teaching attitudes and practices. Further research in this area will serve to benefit professional learning sessions by increasing their effectiveness and practicality for teachers with different mathematics ability levels, years of experience, and grade levels.
References


Schmoker, Mike. (1996). *Results: The key to continuous school improvement.* Alexandria, VA: ASCD.


Appendix A

The 10 Dimensions of Mathematics Education (McDougall, 2004)

Dimension 1: Program Scope and Planning
Dimension 2: Meeting Individual Needs
Dimension 3: Learning Environment
Dimension 4: Student Tasks
Dimension 5: Constructing Knowledge
Dimension 6: Communicating with Parents
Dimension 7: Manipulatives and Technology
Dimension 8: Students’ Mathematical Communication
Dimension 9: Assessment
Dimension 10: Teacher’s Attitude and Comfort with Mathematics
### Appendix B

**Attitudes and Practices to Teaching Mathematics**  
(McDougall, 2004, pp. 87-88)

**Instructions:**  
Select the extent, to which you agree with each statement, according to the A to F scale below.  
Then use the charts at the top of the next page to complete the Score column for each statement.

<table>
<thead>
<tr>
<th>Extent of Agreement</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Strongly Disagree</td>
<td></td>
</tr>
<tr>
<td>B Disagree</td>
<td></td>
</tr>
<tr>
<td>C Mildly Disagree</td>
<td></td>
</tr>
<tr>
<td>D Mildly Agree</td>
<td></td>
</tr>
<tr>
<td>E Agree</td>
<td></td>
</tr>
<tr>
<td>F Strongly Agree</td>
<td></td>
</tr>
</tbody>
</table>

1. I like to assign math problems that can be solved in different ways.
2. I regularly have all my students work through real-life math problems that are of interest to them.
3. When students solve the same problem using different strategies, I have them share their solutions with their peers.
4. I often integrate multiple strands of mathematics within a single unit.
5. I often learn from my students during math because they come up with ingenious ways of solving problems that I have never thought of.
6. It’s often not very productive for students to work together during math.
7. Every student should feel that mathematics is something he or she can do.
8. I plan for and integrate a variety of assessment strategies into most math activities and tasks.
9. I try to communicate with my students’ parents about student achievement on a regular basis as well as about the math program.
10. I encourage students to use manipulatives to communicate their mathematical ideas to me and to other students.
11. When students are working on problems, I put more emphasis on getting the correct answer rather than on the process followed.
12. Creating rubrics is a worthwhile exercise, particularly when I work with my colleagues.
13. It is just as important for students to learn probability, as it is to learn multiplication.
14. I don’t necessarily answer students’ math questions, but rather ask good questions to get them thinking and let them puzzle things out for themselves.
15. I don’t assign many open-ended tasks or explorations because I feel unprepared for unpredictable results and new concepts that might arise.
16. I like my students to master basic operations before they tackle complex problems.
17. I teach students how to communicate their math ideas.
18. Using technology distracts students from learning basic skills.
19. When communicating with parents and students about student performance, I tend to focus on student weaknesses instead of strengths.
20. I often remind my students that a lot of math is not fun or interesting but it’s important to learn it anyway.
### Attitudes and Practices to Teaching Math Survey Scoring Chart

For statements 1–5, 7–10, 12–14, and 17, score each statement using these scores:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

For statements 6, 11, 15, 16, 18, 19, and 20, score each statement using these scores:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

To complete this chart, see instructions below:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Related Statements</th>
<th>Statement Scores</th>
<th>Sum of the Scores</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program Scope and Planning</td>
<td>4, 8, 13</td>
<td>6, 4, 5</td>
<td>15</td>
<td>÷3 = 5</td>
</tr>
<tr>
<td>2. Meeting Individual Needs</td>
<td>2, 6, 7, 15, 16</td>
<td></td>
<td></td>
<td>±5</td>
</tr>
<tr>
<td>3. Learning Environment</td>
<td>3, 5, 6</td>
<td></td>
<td></td>
<td>±3</td>
</tr>
<tr>
<td>4. Student Tasks</td>
<td>1, 2, 11, 15, 16</td>
<td></td>
<td></td>
<td>±5</td>
</tr>
<tr>
<td>5. Constructing Knowledge</td>
<td>5, 11, 14, 115, 16</td>
<td></td>
<td></td>
<td>±5</td>
</tr>
<tr>
<td>6. Communicating With Parents</td>
<td>19, 9</td>
<td></td>
<td></td>
<td>±2</td>
</tr>
<tr>
<td>7. Manipulatives and Technology</td>
<td>10, 18</td>
<td></td>
<td></td>
<td>±2</td>
</tr>
<tr>
<td>8. Students’ Mathematical Communication</td>
<td>3, 6, 10, 17</td>
<td></td>
<td></td>
<td>±4</td>
</tr>
<tr>
<td>9. Assessment</td>
<td>8, 11, 12, 19</td>
<td></td>
<td></td>
<td>±4</td>
</tr>
<tr>
<td>10. Teacher’s Attitude and Comfort with Mathematics</td>
<td>4, 7, 13, 15, 20</td>
<td></td>
<td></td>
<td>±5</td>
</tr>
</tbody>
</table>

**Total Score (All 10 dimensions):**

**Overall Score (Total Score ÷38):**

### Step 1
Calculate the **Average Score** for each dimension:
1. Record the score for each Related Statement in the third column.
2. Calculate the **Sum of the Scores** in the fourth column.
3. Calculate the **Average Score** and record it in the last column.

For example:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Related Statements</th>
<th>Statement Scores</th>
<th>Sum of the Scores</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program Scope and Planning</td>
<td>4, 8, 13</td>
<td>6, 4, 5</td>
<td>15</td>
<td>÷3 = 5</td>
</tr>
</tbody>
</table>

### Step 2
Calculate the **Overall Score**:
1. Calculate the **Total Score** of the sums for all 10 dimensions in the fourth column.
2. Calculate the **Overall Score** by dividing the **Total Score** by 38.

For example:

<table>
<thead>
<tr>
<th>Total Score (All 10 dimensions)</th>
<th>152</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Score (Total Score ÷38)</td>
<td>4</td>
</tr>
</tbody>
</table>

### Step 3
Interpret the results:

<table>
<thead>
<tr>
<th>Average Score for Each Dimension</th>
<th>Overall Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average scores will range from 1 to 6. The higher the average score, the more consistent the teacher’s attitude and teaching practices are with current mathematics education thinking, with respect to the dimension. A low score indicates a dimension that a teacher might focus on for personal growth and professional development.</td>
<td>The overall score will range from 1 to 6. The higher the overall score, the more consistent the teacher’s attitude and teaching practices are with current mathematics education thinking and the more receptive that teacher might be to further changes in his or her practice.</td>
</tr>
</tbody>
</table>
Appendix C

Information Letter

Dear ________,

We are investigating the programs, policies and activities that contribute to student success in mathematics. The purpose of the project is to contribute to the knowledge base regarding school improvement in mathematics and the use of a framework to guide improvement in mathematics instruction as well as to learn about teaching and learning in mathematics in Grade 3 to 6.

The University of Toronto Ethics Office has approved this study.

The project will address such issues as what makes a school successful in terms of improving student achievement in mathematics. We want to know how school administration works collaboratively with teachers to put into place both processes and programs that are effective. We want to see how the use of the Ten Dimensions framework helps with school improvement in mathematics.

We would like you to participate in this project by allowing us to conduct an interview with you. It will take about 45 minutes and it will be tape-recorded. We will conduct the interview during the school day and in your school. You will be given a summary of the interviews and observations. You will also be given an opportunity to receive a summary of the report. I will also be working with you on mathematics improvement. I also plan to work with your school mathematics improvement team to identify strategies to improve mathematics in your school. I would like to tape-record some of these meetings.

We will not use your name or anything else that might identify you in the written work, oral presentations or publications. The information remains confidential. You are free to change your mind at any time, and to withdraw even after you have consented to participate. You may decline to answer any specific questions. We will destroy the tape recording after the research has been presented and/or published which may take up to five years after the data has been collected. There are no known risks or benefits to you for assisting in the project.

Please sign the attached form, if you agree to be interviewed. The second copy is for your records. Thank you very much for your help.

Yours sincerely,

Douglas McDougall
OISE/University of Toronto
doug.mcdougall@utoronto.ca
416-978-0056
Appendix D

Consent Form

Collaborative Inquiry Project: Grade 3 to 6 Mathematics

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw at any time without penalty.

I have read the letter provided to me by Doug McDougall and agree to participate in an interview for the purpose described.

Signature:

Name (printed): ________________________________

Date: ______________

Douglas McDougall
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Appendix E

School and District Improvement in Elementary Mathematics
Principal and Teacher Questions

Length of interview: 30 - 45 minutes

Background questions
What is your name?
Where did you go to university? What is your degree of specialization?
Why did you become a teacher?
How many years have you been teaching?
Where did you teach before and what grades have you taught?
How long have you been here at this school?
What subjects and grades do you teach or what is your role in the school?

1. Versions of success
For you, what counts as success for students in this school?
What are your goals in education?
How widely accepted are your goals with other teachers in the school? Among parents?
How does your school improvement plan incorporate your goals for students?
How is the school improvement plan created in this school (principal)?

2. Challenging circumstances
What are the most challenging things (the barriers) for you as you go about your work in this school?
What are the most successful things for you as you go about your work in this school?
Do you think this school is different from other schools in its challenges?
How would you describe the community of parents with whom you work?
How has the school context changed over the past few years, and what changes are going on now?

3. Mathematics
How would you describe your goals in mathematics?
How widely accepted are these views in the school? Among the parents?
How would you describe the provincial ministry’s vision of mathematics?
How do you meet the mathematics goals of the province?
Which of the Ten Dimensions have you selected for your personal growth? Why did you select those dimensions?
Which of the Ten Dimensions have you selected for your school improvement plan? Why did you select those dimensions?
4. Fostering Mathematics Communication
How would you define mathematics communication?
How do you perceive the role of mathematics communication in your mathematics program?
What mathematics communication goals do you have for your class?
How do you create a classroom environment that fosters students' mathematics communication?
What are some of the challenges you've encountered when attempting to develop students' mathematics communication?
What are some of the successes you've encountered when attempting to develop students' mathematics communication?

5. School support
How do you create an environment, which supports success in mathematics?
What challenges (barriers) have you faced in trying to create a culture that supports student achievement in mathematics?
How do you work with staff and administration to develop the goals/vision of the school?
To develop mathematics improvement?
How were the issues resolved?

6. Overall
What are the programs that support success in mathematics outside of the classroom?
What do you think we should say in our report about how schools can be more effective in supporting mathematics improvement?
Do you have a mathematics implementation team? If so, what is their role and what do they do?