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Effective Mathematics Collaboration
A Mixed Methods Examination of Structural and Cultural Conditions of Effective
Collaboration in Mathematics

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Education

in

Educational Leadership

by

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2013

This Dissertation of Farzin Khosroshahi Dunning is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California, San Diego

California State University, San Marcos

2013

Dedication

This dissertation is dedicated to the many people who have supported me during this long journey. Especially, I am grateful to my husband, James Dunning, for his unconditional love, patience and understanding through this long process. You have sacrificed the most while I have been on this long journey, and I am thankful to you.

To my daughter, Leila Dunning, and my son, Sean Dunning, who have shown me the true meaning of family and what it means to be a mother. You two have been kind and empathetic with me even when I could not spend a lot of time with you.

This research is also dedicated to the memory of my beloved father, Ali Sameii Khosroshahi, and my cherished mother, Aghdas Cham, who both would have been proud of their daughter's accomplishment. Dad, my memory of your encouragement motivated me further to get to this point of my education. Most importantly, I thank god to give me the strength to finish this journey.

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Abstract Of The Dissertation

Effective Mathematics Collaboration
A Mixed Methods Examination of Structural and Cultural Conditions of Effective
Collaboration in Mathematics

by

Farzin Khosroshahi Dunning

Doctor of Education in Educational Leadership

University of California, San Diego, 2013
California State University, San Marcos, 2013

Professor Alan Daly, Chair

For the past two decades, the mathematical achievement of American students has

been a major concern. Students in traditionally marginalized communities often are

affected more and perform less proficient in mathematics due to issues related to teacher

effectiveness. One approach to increase teacher effectiveness has been through

collaboration. The purpose of this study was to explore the structural and cultural

conditions that support high performing collaboration in mathematics. This study not

only investigated the supporting structural and cultural conditions that have been

identified in the extant literature but it also examined the interaction between these

conditions in two high performing cases. The study also provided an opportunity to

examine teachers' perception of collaboration and its influence on their teaching. The

investigation relied on the frameworks of the structural conditions—including duration, coherence, content, active learning, and collective participation—and two cultural conditions of teacher efficacy and trust. Using mixed method, the methodology of the study used surveys and interviews to identify the supportive conditions and the interactions between these conditions in two instructive cases of collaboration. The findings revealed six structural themes of time as an important condition of collaboration, focus on teachers' daily classroom goals, focus on teachers' content knowledge, teacher learning through collaboration and participation of teachers of the same grade level. The findings also pointed to high level of collective efficacy and trust as supportive cultural conditions. The significant finding of this study was the new theoretical model, Interdependence Model. This new model includes one additional structural condition of physical proximity, and two additional cultural conditions of focus on students' best interest and culture of high expectation. This new model reflects intense interconnection and interdependence between the structural conditions, cultural conditions. This model shows that the cultural conditions lay the foundation for the development of the structural conditions. More importantly, the Interdependence Model presents that trust is the most critical predictor for the development of the structural conditions. It is hoped that the new theoretical model, which originated from a strengths-based approach, will reinforce the conditions that exemplify high-performing collaboration in schools.

Chapter One: Introduction to the Study

Introduction

The purpose of this study is to investigate the conditions that support the collaboration of middle school mathematics teachers and the interactions between these conditions. This study also investigates teachers' perception of their teaching practice as a result of the collaborative work they do. The following sections present the background of the problem, conceptual frameworks for the study, statement of the problem, purpose of the study with research questions, epistemology, methodology, significance of the study, limitations, and a summary.

Background

For the past two decades, the mathematical achievement of American students has been a major concern. In 2005, the National Center for Education Statistics (NCES, 2006) reported that less than one-third of eighth-grade students performed at the proficient level in mathematics—a level that defines a basic competency of a specific subject matter. They also found that as many as one-fifth of fourth-grade students and one-third of eighth-grade students lacked the skills to execute basic mathematic computations. The Program for International Student Assessment (PISA, 2006) reported that American students ranked 21st out of 30 in science literacy among students from developed countries and 25th out of 30 in math literacy. The National Assessment of Educational Progress (NAEP, 2009) reported that fourth graders showed no signs of

progress for the first time in many years, and eighth graders tallied only modest evidence of progress. These alarming reports call for the urgent need to improve the quality of teaching and learning in mathematics.

Students in traditionally marginalized communities often are affected more and perform less proficient in mathematics due to having less effective teachers. Although high-poverty and high-minority schools may include dedicated teachers, the number of teachers who are not highly trained in these schools continues to rise (Haycock, 1998). A portion of the achievement gap on the National Assessment of Educational Progress and other standardized assessments might result from teachers with less mathematical knowledge teaching more disadvantaged students (Haycock, 1998).

To address this issue, a number of reforms and policies have been put in place to increase teacher effectiveness and student achievement. Reform efforts, such as Goals 2000—established by the Council of State Governors in 1994, helped to create national education goals and standards. The No Child Left Behind Act (NCLB, 2001) requires schools to make adequate yearly progress (AYP) toward state and federal standards and meet the growth targets. In addition, NCLB specifies the need for highly qualified and effective teachers to be present in every school receiving Title I funding (Darling-Hammond & Sykes, 2003). The most recent effort is President Obama's plan to provide states with a waiver package, which will provide flexibility to ensure students are prepared for college, career, and competition in a global economy by receiving a high-quality education (The White House, 2011).

A high-quality education is highlighted by effective teaching. Haycock (1998) correlates effective teaching with high-level curriculum knowledge, enhanced teaching

skills, and high expectations. The findings of a longitudinal study done by Sanders and Rivers (1996) revealed that the differences in student achievement vary as much as 50 percentile points as a result of three-year teacher sequences when students are assigned to effective teachers three years in a row. The study also showed that the effects of the classroom teacher on low-achieving students are dramatic. The more effective teachers showed gains of 52 percentile points with low-achieving students while the least effective teachers demonstrated a gain of 14 percentile points for these students (Sanders & Rivers, 1996). Over a three-year period, students with three ineffective teachers demonstrated an average of the 29th percentile on fifth grade math scores. Students who were assigned to effective teachers for three years boasted an average of the 83rd percentile on the same assessment.

Since schools where culturally and socioeconomically disadvantaged students are more at risk of failing, effective teachers are even more crucial. Lack of academic success among diverse students may be due to the lack of teachers' understanding on how students from different cultural background learn. In his speech on closing the achievement gap, Jack O'Connell, the previous California state superintendent of schools said, "These are not just economic achievement gaps, they are racial achievement gaps, and we cannot afford to excuse them; they simply must be addressed" (Landsberg, Blume, & O'Connell, 2007, p. 1). His invitation to address the issue challenged district leaders to become more proactive in constructing and implementing programs with a focus on increasing teaching effectiveness and student achievement. PD programs increase teachers' awareness of culturally influenced learning and behavior differences in the classroom and can enhance the teaching effectiveness and learning of culturally

diverse students (Krose, 2007; Voltz, Brazil, & Scott, 2003). When teachers are provided with opportunities to inquire about teaching and student learning, they become more effective in their classrooms.

Hence, one of the most promising approaches to increase teacher effectiveness and student achievement has been through PD programs. PD as a response to systematic reform efforts has potential to increase teacher's content knowledge and effectiveness (Birman et al., 2000). The government offers substantial financial resources to schools through the Elementary and Secondary Education Act to provide PD for teachers. Perhaps even more significant, PD funding is available though Title I disbursements, from which $988 million were utilized for teacher PD in 2005 (Birman et al., 2007).

In spite of available funding and considerable efforts to implement PD, schools have continued to struggle with how best to prepare and train qualified and effective teachers (Hirsh, 2005). Not all forms of PD have been successful in improving student outcomes. In a 2010 report by the U.S. Department of Education, a nationwide controlled study examined teacher PD programs, which consisted of 10 days of summer institute and two weeks of on-site coaching in mathematics. The findings revealed the PD programs in this study had no effect on teacher learning or student learning. In large part, this might have been due to the fact that most PD programs in this study lacked important features required to make these PD programs effective (Garet et al., 2010). Thus, it becomes critical to investigate the factors that influence the effectiveness of PD programs in schools and provide educational leaders with information that might strengthen the effectiveness of their existing PD programs.

Conceptual Framework

If the goal is to meet the needs of increasingly diverse student populations and to enhance student achievement, teacher effectiveness needs to be increased. Teacher effectiveness is a crucial factor for student achievement. Hammond (1997) states, "Teachers who know a lot about teaching and learning and who work in environments that allow them to know students well are the critical elements of successful learning" (p. 8). Vogt (1984) associates effective teaching with teachers' ability to provide instruction to students from different abilities while evaluating the effective learning mode of the students. Collins (1990) states an effective teacher is committed to student learning, knows the subject, reflects on his/her own practice and is a member of the learning community.

One way to increase teacher effectiveness is through PD programs that are effective and have potential to improve teaching (Carpenter et al., 1989). Effective PD programs provide teachers with new knowledge and skills that can be applied to teachers' everyday practice (Joyce & Showers, 2002). The National Commission on Mathematics and Science Teaching for 21st Century (2000) concludes that better mathematics and science teaching depends on the development of ongoing effective PD programs. One strategy toward enhancing teaching practice could be investing in a variety of effective PD programs and increasing mathematics content and pedagogy knowledge among teachers—particularly teachers working in schools with disadvantaged students (Ball, Hill, & Bass, 2005).

Recognizing the critical features in the construction of effective PD program is the key to transforming teachers' beliefs and practices. In the last 20 years, educational

leaders and researchers have focused on designing a more effective PD model. The body of research created through these efforts indicates that effective PD programs offer a variety of planned collaborative activities providing opportunities for teachers to plan instruction, observe each other's classroom, provide feedback, and share effective teaching practices (McLaughlin & Talbert, 1993; Rosenholtz, 1989). A number of empirical studies indicate that PD programs utilizing planned collaborative activities increase teachers' classroom effectiveness (Drago-Severson & Pinto, 2006; Lieberman, 2009; Margolis, 2008; Zwart, Wubbles, Bergen, & Bolhuis, 2009). PD programs that promote collaboration may be one way to narrow the achievement gap (Ball et al., 2005).

Planned activities such as study groups and other collaborative groups are known to be reform-type PD (Birman, Desimone, Porter, Yoon, & Garet, 2000). This type of PD program, which is embedded in teachers' regular school day, offers long-term collaborative opportunities that are intentionally planned and are related to teachers' everyday work (Villegas-Reimers, 2003). Unlike traditional PD, which includes a number of disconnected meetings, workshops, and conferences, reform PD establishes a mindset that focuses on ongoing teacher learning and encourages teachers to continuously look for ways to improve their instruction. Teachers of reform PD continuously look for ways to improve their own instruction through books, videos, or conference workshops while collaborating with other teachers. They observe colleagues in their classrooms and follow up with discussions about what they saw or heard or practiced in their classrooms (Holland, 2005). In schools where these approaches to PD have been established, teacher learning is evident. In this way, teachers move beyond a

traditional definition of PD and begin to establish a true learning community (Holland, 2005).

Several national reports have linked effective PD to reform PD, in which teachers participate in planned activities that are related to their everyday practice during school hours (Villegas-Reimers, 2003). The National Education Goals Panel's report (2000) links reform PD to student achievement (NEGP Monthly, 2000). Another report provides evidence of the link between reform-type PD and improved teaching and student learning in mathematics (Wenglinsky, 2000). The results of a three-year longitudinal study of the federal Eisenhower PD program indicated that when PD was of the reform type, it promoted active teacher learning, collective participation of teachers from the same grade level, and coherence. This type of reform PD—which included teacher study groups, inquiry groups, and other collaborative groups—helped teachers to increase their use of strategies in their mathematics and science classrooms (U.S. Department of Education, 2000). Teacher participation in reform-type PD results in higher student achievement for minority students, particularly in mathematics (Johnson, Kahle, & Fargo, 2007).

It is important to note that the success of the reform PD program depends on the strength of its collaboration. Although collaboration is an integral component of the reform PD program, it is not sufficient. There are numerous factors that influence the success of any reform PD program featuring collaboration and those factors need to be investigated. Some of these factors have to do with the structural characteristics and others are related to teachers' psychological state in school context. Factors that are related to teachers' psychological state will be referred to as cultural factors in this study.

To identify effective PD, Birman et al. (2000) surveyed more than 1,000 teachers

who participated in PD sponsored by the federal government's Eisenhower Professional Development Program. They concluded that effective PD activities are collaborative, focus on content knowledge, and offer coherent activities that have greater duration and involve collective participation. They reasoned that since reform-type PD activities offer greater duration, active learning, and coherence, they are more effective than one-time workshop programs (Birman et al., 2000). The reform-type PD programs include collaborative activities that are intentionally planned, have specific goals and relevance to teachers' everyday work, and are embedded in teachers' regular day (Sparks, 2002).

In a later study, Birman, Desimone, Porter, Yoon, and Garet (2002) examined PD activities of 207 teachers in 30 schools and in 10 districts in five states to understand the features of effective PD programs in the instruction of mathematics and science. The study selected one elementary school, one middle school and one high school in each of the 10 districts. The findings revealed that PD activities that had the most impact on teaching mathematics were collaborative and shared five common characteristics. The common characteristics of reform PD activities included an extended duration, collective participation, active learning, coherence, and focus on content (Birman et al., 2002). These characteristics will be referred to as the structural conditions and are identified in other empirical studies as well (Jeanpierre, Oberhauser, & Freeman, 2005; Johnson et al., 2007; Penuel et al., 2007).

This study will specifically examine the characteristics of collaboration in reform PD as a framework to better understand the structural conditions of effective PD in mathematics and the extent to which these conditions are related to improved teaching in mathematics.

In addition to the importance of structural conditions on the outcomes of successful mathematics collaboration, other conditions related to teachers' efficacy and trust play a significant role in the outcomes related to teachers collaboration. Personal characteristics—such as teacher efficacy and trust—influence teachers' willingness to collaborate with their colleagues (Fisler & Firestone, 2006). Teacher self-efficacy and trust affect what teachers learn from the work they do with their colleagues (Chester & Beaudin, 1996; Esselman & Moore, 1992; Hoy & Woolfolk, 1993; Rosenholtz, 1989). Thus, further investigation about effective collaboration in mathematics needs to include the effect of teachers' trust and self-efficacy on the outcomes of teacher collaboration. This study will refer to teacher efficacy and trust in schools as cultural conditions.

The literature on the impact of both structural and cultural factors on teacher collaboration remains thin. Although structural factors are important and play a significant role in the outcomes related to the collaborative activity in question, the role of cultural factors as they relate to individuals and groups must not be overlooked. While the structural factors have often been argued, the importance of the cultural conditions on teacher collaboration is missing. There are studies connecting structural factors to collaboration and studies showing the relationship between cultural factors and collaboration, but only a few studies link both structural and cultural factors to the collaborative component of reform PD in mathematics. This study will attempt to uncover the connection between both sets of conditions and mathematics teachers' collaboration by examining two high performing cases of collaboration. The findings of this inquiry will help us to develop a better understanding of effective collaboration in mathematics.

Statement of the Problem

There is an ongoing concern with the underperformance of disadvantaged students in mathematics because teachers with less qualifications and content knowledge are teaching disadvantaged students (Haycock, 1998). This critical issue needs to be addressed because the strengths of the nation's economy depend on the quality of education that students receive in schools. President Obama (2011) stated,

> A world-class education is the single most important factor in determining not just whether our kids can compete for the best jobs but whether America can out-compete countries around the world. America's business leaders understand that when it comes to education, we need to up our game. That's why we're working together to put an outstanding education within reach for every child.

It is important to provide our nation's low-income and disadvantaged students with high-quality education in order to reduce crime, strengthen national security, and boost U.S. competitiveness in the global market (U.S. Department of Education, 2011).

Another issue stems from the fact that not all reform PD programs based on collaboration increase teacher effectiveness and student achievement. Many districts and schools are implementing reform-type PD programs that are collaborative in nature, such as professional learning communities (PLCs). However, not all PLCs are improving teaching and student learning (Garet et al., 2010). For example, some schools are creating weekly PLC time for teachers to collaborate without specifying structures, planned activities and goals (Levine & Marcus, 2008). Teachers whose collaborative activities lack structure and focus limit their learning and improvement (Levine & Marcus, 2008).

In addition, the success of teachers' collaboration depends on trust and teacher efficacy in schools (Chester & Beaudin, 1996; Esselman & Moore, 1992; Hoy & Woolfolk, 1993; Rosenholtz, 1989). This study aims at uniting structural and cultural factors that influence teacher collaboration. The next sections will explain the purpose of the study, the research questions, and how this study will address the research questions.

Purpose of this Study

The purpose of this inquiry is to explore the structural and cultural conditions that support middle-school mathematics teachers' collaboration. This unique study will investigate the impact of both structural and cultural factors and their relationship in a new way to better understand effective collaboration in mathematics. Using quantitative and qualitative data, this study will answer the following research questions:

Research Questions

1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?
2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?
3. What are teachers' perceptions of collaboration and its influence on their teaching?

Researcher Epistemology: Participatory Inquiry

I believe people learn in collaboration with others through experimenting in the context in which they work every day. Within the last 12 years of teaching mathematics, I have acquired my own knowledge about teaching mathematics in collaboration with my

fellow seventh-grade teachers. I work with my team members every year to modify the curriculum and pedagogy in an attempt to enhance teaching and produce a better result for students. Participatory inquiry states that people within cooperative inquiry collaborate to define the questions they wish to explore and the strategy for that exploration (Heron, 1996; Reason & Heron, 1995). When team members apply this strategy to everyday classroom practice, they generate practical knowing, which leads to new ways of teaching (Heron, 1996; Reason & Heron, 1995). The focus of participatory inquiry is practical knowing while working with others, which corresponds with how we learn what we know. We acquire new knowledge by exploring and identifying our own problems and working with others to find solutions.

Methodology

The research design of this project is mixed methods research combining quantitative and qualitative research techniques into a single study (Johnson & Onwuegbuzie, 2004). The unit of analysis for this study is middle-school mathematics teachers in two districts known to have schools with strong collaboration. I will interview the key leaders of these districts to confirm the good reputation of strong collaboration.

In order to "understand phenomena deeply and in detail" (Morse, 2007, p. 30), I will collect data from surveys and interviews. The two sources of data will help me to add validity to the findings. The survey will provide quantitative data about the structural and cultural factors that are in place in schools' existing collaboration. The findings of the survey will also be used to select two high performing cases and guide the interviews.

The data from the interviews will be another tool to validate quantitative data and provide additional in-depth qualitative data about the structural and cultural factors and their interaction influencing the degree to which teachers collaborate.

This design will use a two-case study model with a survey on both structural and cultural factors. The survey will serve to identify and measure the structural and cultural conditions that are in place at each school's collaborative activities. The survey, which will be used not only as a data source but also as the selection criteria for the two high performing cases, will be administered to all middle schools within two districts. The findings of the survey will help to measure the strengths of collaboration at different sites and identify two cases with the strongest mathematics collaboration. Using a strengths-based approach, the findings of the survey will guide the study to identify two instructive cases of collaboration and conduct an illustrative case of high-performing collaboration. The case study will further investigate the structural and cultural conditions and the interaction between these conditions resulting in strong collaboration in the two identified cases (Miles & Huberman, 1994).

Significance of the Study

The findings of this study will provide information on supports and constraints related to effective mathematics collaboration. This study will make a unique contribution to the existing literature by unifying a variety of literatures on both structural and cultural factors to better understand mathematics collaboration. With increased awareness about the factors that influence the outcomes of teacher collaboration, school

leaders may become more proactive in facilitating these conditions and influencing the teaching and learning of mathematics in middle schools.

Summary

Recent reports on student mathematical achievement indicate that the achievement gap for U.S. students within the last two decades has grown at a rapid rate. One approach to improving student achievement across the academic spectrum has been to provide PD programs to increase teacher-classroom effectiveness. In spite of available funding and considerable efforts to implement PD, schools have not succeeded in providing effective PD that improves teaching. Arguably, a school's inability to construct effective PD programs may account for persistent poor achievement outcomes, particularly among low-income and minority students.

A number of empirical studies have identified reform-type PD that is based on collaboration as an effective way to enhance teaching practice and improve student learning in mathematics. However, the body of literature on collaboration lacks specific information regarding the influence of both structural and cultural factors on the outcomes of teacher collaboration in mathematics. This study will identify the essential structural conditions needed for effective collaboration by referring to the work of Birman and colleagues (2002). In their attempt to further operate and understand effective PD in mathematics, they concluded that effective PD programs should be reform type based collaboration and include characteristics of duration, active learning, content, coherence, and collective participation. Reform-type PD is associated with collaboration that occurs during work hours and support teachers' everyday classroom

needs (Meyer et al., 2006). This collaboration may occur within PLCs (Levine & Marcus, 2010). Additional studies linked the collaboration component of reform PD and its structural features to improved teaching practice (Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al., 2007).

While these studies are important in identifying the features of effective collaboration in mathematics, they have not attended to the important cultural factors that support or undermine the collaboration. The success of collaboration in reform PD programs depends not only on the structural features, but also on cultural factors such as self-efficacy and trust. The variation in the levels of self-efficacy and trust in schools might influence the outcomes of collaboration in reform PD programs (Fisler & Firestone, 2006). Thus, with the understanding that structural features are critical for effective collaboration, this research will further investigate the impact of cultural factors, including self-efficacy and trust, on the effectiveness of teacher collaboration in mathematics.

Chapter 2 will offer a review of current literature on the topic. Chapter 3 will introduce the methodology and Chapter 4 will present the data analysis. The study will conclude with discussions, recommendations, and conclusions in Chapter 5.

Chapter Two: Review of the Literature

The previous chapter shed light on the rapid growth of the achievement gap for disadvantaged students in mathematics within the last two decades. It also suggested how reform-type PD combined with a collaborative approach might be effective in increasing teacher effectiveness and student achievement in mathematics. The chapter established an argument pertaining to the need to implement reform PD programs using collaboration while illustrating the need for an investigation of structural and cultural factors that influence the outcomes of the collaborative component of reform PD programs.

Despite considerable efforts to implement PD programs for teachers, schools continue to struggle with how best to enhance teacher effectiveness in mathematics (Hirsh, 2005). This is due to the fact that not all PD programs have been effective (Garet et al., 2010). A number of studies have identified a reform-type PD with a collaborative approach to be an effective way to improve teaching mathematics. While there is much discussion on reform-type PD and collaborative approach, the understanding of the specific structural and cultural factors that cause variations in the outcomes of collaboration is still in its infancy. This literature review brings a variety of resources on both structural and cultural factors to better understand reform PD and its collaborative approach in mathematics.

Reform Professional Development and Collaboration

Since the 1990s educational leaders and researchers have focused on designing a more effective PD model to improve teaching and student learning. The body of research

indicates that a reform-type PD with collaborative approach may be one way to improve teaching and narrow the achievement gap (Ball et al., 2005; Birman et al., 2002). Particularly, participation of mathematics teachers in reform PD has resulted in higher student achievement in mathematics (Johnson et al., 2007).

Reform PD programs utilize collaborative activities that are embedded in teachers' regular school days and offer long-term collaborative opportunities that are intentionally planned and are related to teachers' everyday work (Villegas-Reimers, 2003). Teacher collaborative groups and study groups are examples of reform PD (Birman et al., 2002). Reform activities usually take place during classroom instruction or regularly scheduled teacher planning time. Hence, they may be more likely than traditional forms to make connections with classroom teaching, and they may be easier to sustain over time. The reform types of activities are more responsive to teachers' needs and goals (Darling-Hammond, 1995) and how teachers learn (Ball, 1996), and may have more of an impact on changing teaching practice (Darling-Hammond, 1995, 1996; Hargreaves & Fullan, 1992; Little, 1993; Richardson, 1994; Sparks & Loucks-Horsley, 1989; Stiles, Loucks-Horsley, & Hewson, 1996).

Unlike more traditional PD—which may include a number of disconnected meetings, workshops, and conferences—reform PD establishes a mindset that focuses on ongoing teacher learning and encourages teachers to continuously look for ways to improve their instruction. Teachers of reform PD continuously strive improve instruction through books, videos, or conference workshops while collaborating with other teachers during school hours. They observe colleagues in the classroom and follow up with discussions about what they saw, heard, or practiced in their classrooms. In schools

where these approaches to PD have been established, teaching improvement is evident (Holland, 2005). In this way, teachers move beyond a traditional definition of PD and begin to establish a true learning community.

Some schools and districts have started to implement reform PD activities as ongoing PD for teachers. Examples of reform PD programs include Professional Learning Communities, PLCs, study groups, teacher academies that offer ongoing seminars and courses of study tied to practice, school-university partnerships that sponsor collaborative research (Birman et al., 1999), and a variety of formal and informal learning opportunities developed in response to teachers' needs (Darling-Hammond, 1997).

This literature will refer to PLCs, study groups, and a variety of collaborative activities such as collective-teacher inquiry, classroom-based research, and lesson study to show examples of reform PD and collaboration in mathematics.

PLCs are considered a reform PD and have been implemented by a number of schools (Levine & Marcus, 2010). DuFour (2000) states that if schools are to be more effective with teaching and learning, a new model of PD allowing them to function as learning organizations must be embraced. DuFour challenges educators to create PLCs, where the emphasis is placed on student achievement, collaboration, and shared teaching ideas. PLC is defined as an educational organization characterized by shared mission, collective inquiry, and collaboration and shows continuous improvement, is student centered, and is result oriented (DuFour, 2007). PLCs provide a context of collegiality that encourages teachers to learn new instructional strategies and improve their practice in collaboration with others. The collaboration component of PLC is supported by a

number of studies (Birman et al., 2002; Gusky, 2002; Jeanpierre et al., 2005; Johnson, et al., 2007; Joyce & Showers, 2002; Penuel et al., 2007).

Study group as a reform PD is a gathering of individuals who meet on a regular basis to address issues they have agreed to study. Similar to PLCs, a study group organizes a group of teachers—who come together based on similar interests, instructional levels, and curricular areas—into a community of learning teams. The formation of study groups calls for careful planning, purpose, and focus on issues at hand. Similar to PLCs, study groups have the same characteristics associated with learning communities and can be used to provide the framework for the development of culture of collaboration and the building of learning communities (Roberts, 2008).

Reform PD programs, such as PLCs or study groups, focus on teacher collaboration. Through collaboration teachers share teaching practices, plan instruction, observe each other's classroom, provide feedback, and acquire practical knowledge resulting in the enhancement of their classroom effectiveness (Drago-Severson & Pinto, 2006; Lieberman, 2009; Margolis, 2008; McLaughlin & Talbert, 1993; Rosenholtz, 1989; Zwart et al., 2009).

The findings of a study done in 47 elementary schools with 452 teachers from a large urban school district located in the Midwestern United States indicated that teacher collaboration was positively related to differences among schools in both mathematics and reading achievement. In fact, schools with greater levels of teacher collaboration developed more effective teachers and had higher levels of student achievement (Goddard, Goddard, & Tschannen-Moran, 2007).

In summary, this literature suggests that effective PD is reform-type PD offering

ongoing planned collaborative activities embedded in teachers' regular school day and related to teachers' everyday work. Teacher collaborative groups, PLCs, and study groups are examples of reform PD.

There are multiple structural and cultural conditions that influence the success of collaboration piece of reform PD programs. While a number of studies that have identified the structural conditions that support the collaboration of reform PD efforts, they have not attended to the important cultural conditions that support or undermine the process. The success of the collaboration components of reform PD depends not only on the structural features, but also on cultural factors, such as teacher self-efficacy and trust.

To understand the structural conditions of effective PD programs in the instruction of mathematics and science, Birman and colleagues (2002) examined PD activities of 207 teachers in 30 schools in 10 districts in five states. The findings revealed that PD activities that had the most impact on teaching were reform type and shared five common characteristics. The reform-type PD includes collaborative activities that are intentionally planned, have foci and relevance to teachers' everyday work, and are embedded in teachers' regular day (Sparks, 2002). The common characteristics of reform PD activities included an extended duration, collective participation, active learning, coherence, and focus on content (Birman et al., 2002). The reform PD and these five characteristics have been identified in other empirical studies as well (Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al., 2007). This study will use the reform PD and these five characteristics as a framework to better understand the conditions of effective collaboration in mathematics.

The following sections will explain three examples of reform PD in mathematics, which may occur within PLCs, study groups, or other collaborative groups. All these reform PD models show collaboration as their main component. The collaboration in these models reflect both structural and cultural factors; however, our understanding of the intersection between these two sets of factors is limited.

Collective Teacher Inquiry. Teachers who apply an inquiry model in their practice are examples of reform PD. The inquiry process involves collaborative activities that are intentionally planned and have specific goals and relevance to teachers' everyday work (Sparks, 2002). When teachers utilize an inquiry approach as active learners, they perceive their teaching as an ongoing reflective practice aimed at solving individual problems (Slavit & Nelson, 2009). According to Slavit and Nelson (2009), the questions emerging from teachers' own classroom experiences guide them through an inquiry cycle. The inquiry cycle consists of a process of interconnected activities, including a focusing and planning period, the implementation of a common teaching practice or other collaborative activity, and a period of assessment. In this model, teachers build a collaborative stance to address the issues at hand and further their individual and collective understanding of the problems. In reporting her own active learning experience when using a collective teacher inquiry approach, Wirsing noted, "Collective teacher inquiry provided the ongoing professional development I needed to dedicate the time to interact with the subject matter and work with a network of teachers, a resource that will keep on giving" (2009, p. 31).

The collective teacher inquiry model has been particularly effective in improving the teaching practice of mathematics teachers. This model has provided teachers with a

tool to build theory on issues related to the teaching and learning of mathematics (Slavit & Nelson, 2009). The collective teacher inquiry model in mathematics includes focused discussion and critical dialogue on student thinking (Kazemi & Franke, 2004). Collaborative development of lesson plans, discussions of issues on hand, and analysis of student work are some of the common aspects of a teacher inquiry cycle requiring a facilitator to sustain a focused dialogue and move teacher interaction to critical levels. In a yearlong PD project involving 175 mathematics and science teachers in six school districts, Kazemi and Franke (2004) revealed that participation in PD centered on collaborative teacher inquiry exhibited specific connections between their collaborative inquiry and their instructional practice. The collaboratively developed lesson plans created in this process helped teachers to jointly explore ideas, develop specific instructional techniques, and apply what they had acquired in their own classrooms. It was noted that the facilitators had an important role in sustaining teachers' focus on sharing similar conjectures, assessing appropriate scaffolding, and assisting teachers in discussing collective theories around issues (Kazemi & Franke, 2004).

In a similar study by Slavet and Nelson (2009), a yearlong collaborative inquiry among a group of mathematics teachers focused on increasing student engagement and problem-solving skills. The findings revealed a direct link among the processes of collaborative teacher inquiry model, teacher interactions, and classroom practice. It was found that the collaborative inquiry led teachers to construct specific, usable theories related to scaffolding student engagement with mathematical tasks. These theories involved sequencing instruction and supporting students' mathematical thinking and

problem solving. Thus, teachers were able to increase student engagement, problem solving, and mathematical learning in their classrooms (Slavit & Nelson, 2009).

In summary, collective teacher-inquiry model as a reform PD in mathematics reflects the five structural characteristics of effective PD programs. This collaborative model, which is based on collective participation of teachers from the same grade level teaching the same content, is made up of connected activities that are coherent, ongoing, and content focused. This model also provides opportunities for teachers to become active learners by collectively developing theories and solutions for teaching and learning in mathematics.

Although generally successful, the collective teacher inquiry model can be more effective when it is integrated with the collaborative approach through close partnerships between teachers and researchers (Rathgen, 2006). Through partnership with researchers, teachers can improve classroom practices through ongoing feedback and reflection. The next section will discuss how this partnership, which is a variation to teacher-inquiry model, can result in more successful outcomes for teaching.

Participation in Classroom-Based Research. Teachers take an active role in their own learning when they participate in collaborative work with researchers. This type of collaborative model—which also features the characteristics of reform-type PD and the five structural elements of effective PD—promotes a learning inquiry of mathematics in which all participants focus on questioning about different aspects of teaching, purposes of teaching, and reflective activities (Potari, Sakonidis, Chatzigoula, & Manaridis, 2010). In this collaborative model, teachers and researchers mutually agree

to become partners in an inquiry process of teaching and learning mathematics—maintaining separate but compatible roles (Potari et al., 2010).

A five-year study examining the partnership between teachers and researchers in Australia and Canada showed positive results for teaching mathematics (Erickson, Branders, & Mitchell 2005). An analysis of the empirical data revealed that facilitating effective partnership between teachers and researchers was successful in improving the teaching practice and student learning in mathematics.

Rathgen (2006) found a similar effect of collaboration between teachers and researchers who had participated in classroom-based research projects. The teachers reported their participation in research that related to how their own classroom concerns contributed to their overall learning ultimately improving their teaching. Teachers also noted how reflections on their own classroom experience assisted in learning more about aspects of their own practice (Rathgen, 2006).

A recent report on PD from the U.S. Department of Education (2010) showed the importance of collaboration between teachers and researchers in the teacher inquiry process—and specifically in relation to mathematics. Teachers not only need to increase their content knowledge in mathematics, they also need opportunities to understand how students learn mathematics. When teachers use research-based knowledge relating to how students' develop effective mathematical thinking, only then can they influence student achievement. Providing teachers access to research-based knowledge about students' thinking and problem solving can affect teachers' beliefs about learning and teaching mathematics, classroom practices, and students' achievement (Carpenter et al., 1989). With research derived from studies on student thinking, teachers could increase

understanding of the processes of student learning of concept in mathematics.

For example, the Cognitively Guided Instruction (CGI) research project investigated whether providing teachers access to explicit knowledge derived from research on students' thinking in a specific content domain would influence the teachers' instruction and their students' achievement (Carpenter et al., 1989). In this study, 20 first-grade teachers were provided research-based knowledge on the analysis of student development of problem-solving skills in addition and subtraction. The study was aimed at helping teachers understand how children develop addition and subtraction concepts and provided teachers with the opportunity to explore how they might use that knowledge in the classroom. The findings indicated that teachers participating in the CGI training taught problem solving more and number facts less than teachers not trained in CGI. The participants of CGI also knew more about individual students' problem-solving processes and made more informed instructional decisions. As a result, the students of trained teachers used a variety of problem-solving strategies and performed higher in addition and subtraction assessments than students of teachers who were not trained (Carpenter et al., 1989).

The collaboration between teachers and researchers improves teachers' classroom practice by providing a safe learning community in which teachers are actively involved in the reflective process of learning mathematics and instructional skills (Brown & Benken, 2009). The collaboration between teachers and researchers is one way to develop knowledge through community and the reflective process (Potari et al., 2010). The reflective process within the collaboration between teachers and researchers in a learning community of inquiry effectively allows teachers to develop their own

pedagogies about mathematics. A four-year empirical case study investigated the outcomes of collaboration among five mathematics teachers and two academic researchers in mathematics education from a community of inquiry perspective. The collaboration between the teachers and researchers in this study gave rise to an emerging community of inquiry, in which teachers took initiative to improve their own practice of teaching mathematics through a systematic reflective process (Potari et al., 1989).

Another example for this type of collaborative model can be seen in a five-year study investigating the impact of collaboration between Science, Technology, Engineering, and Mathematics (STEM) faculty and classroom teachers through the Math and Science Partnership (MSP) program. The MSP program is a research and development effort to improve K-12 student achievement in mathematics and science. The goal of MSP projects is to raise the achievement levels of all students and reduce achievement gaps in the mathematics and science performance of diverse student populations. The MSP helps STEM faculty to increase their knowledge and skills in working with K-12 teachers (Zhang, McInerney, & Frechtling, 2010). In a five-year study utilizing MSP, teachers were provided with PD that featured collaboration between STEM faculty and teachers (Zhang et al., 2010). This PD was designed to enhance teachers' content and pedagogical knowledge in mathematics. The findings illustrated that STEM faculty were able to enhance classroom instruction of mathematics by inclusion of a questioning style, constant probing, and explanation of underlying concepts. It was noted that teachers felt STEM faculty transmitted subject pedagogy to an even greater extent than content. Teachers also remarked on the difference their

engagement with STEM faculty made in their personal confidence in teaching mathematics (Zhang et al., 2010).

When teachers utilize research-based principles into classroom practice, they become more learner-centered, utilize rich collaborative tasks, and ask high-level questions (Swana & Swain, 2010). They also develop a better understanding of how students learn mathematics by creating a risk-free learning environment in which students feel more relaxed and less worried about making mistakes (Swana & Swain, 2010).

In summary, the model of participation in classroom-based research reflects the characteristics of reform PD and other structural components including duration, content, coherency, active learning, and collective participation. The findings of a number of studies showed this model produces positive outcomes for the teaching of mathematics. Another type of reform PD with collaboration in mathematics—known as lesson study— has also been shown to have positive impact on the teaching of mathematics. This collaborative model reflects the structural features as well.

Lesson Study. The development of communities of mathematics learners has become an important requirement for the success of PD programs. Lesson study, as a reform-type PD, has proven to be effective in developing communities of mathematics learners. Lesson study, which is a Japanese form of PD, centers on the collaborative study of live classroom lessons (Lewis, Perry, Hurd, & O'Connell, 2006). In lesson study, teachers collaboratively plan, observe, and analyze actual classroom lessons, drawing out implications both for the design of specific lessons and for teaching and learning (Lewis et al., 2006).

The collaborative activities embedded in lesson studies have the potential to

provide teachers with improved instruction in mathematics and increased student learning (Puchner & Taylor, 2006; Lieberman, 2009). Through the collaborative activities of lesson studies, teachers are able to change their lesson plans from teacher-centered lessons to student-centered lessons, involving students in the construction and development of the concepts (Fernandez, 2010). The ongoing connected activities of lesson studies provide teachers with opportunities to enhance their classroom practice (Penuel et al., 2007) by selecting long-term learning goals based on topics of interest.

In the late 1990s, Highlands School in San Mateo-Foster City (SMFC) School District began to utilize lesson study as a PD model that would support sustained, teacher-led improvement of classroom instruction—which is an instructional improvement plan. The lesson study model in this school provided teachers with opportunities to become researchers, test their new knowledge on their students' thinking about mathematics, and increase both their content and pedagogical knowledge in mathematics (Lewis et al., 2006).

Student achievement data at Highlands suggested that the lesson study model produced positive outcomes for students as well. An analysis state mathematics achievement tests compared Highlands scores with those from schools throughout the district and state over a three-year period. The analysis found that, for the same period, the net increase in mathematics achievement for students who remained at Highlands School was more than triple that for students who remained elsewhere in the district as a whole (an increase of 91 scale score points compared to 26 points), a difference that was statistically significant (Lewis et al., 2006). School-wide lesson study appeared to be the

primary difference between the PD at Highlands and the practices of other district schools during the years studied (Lewis et al., 2006).

It is important to note that the potential success of lesson studies in mathematics depends on the structure of collaborative activities (Parks, 2008). A number of studies in the literature have documented the role of teacher leaders in providing structured collaboration and facilitating effective dialogue with a focus on content and instructional strategies in mathematics (Printy, 2008). The findings of one study in Dutch secondary schools indicated that the frequency of activities—such as reflective dialogue, classroom observations, and lesson preparations—within mathematics departments may have increased with the influence of teacher leaders (Visscher & Witziers, 2004). In a more recent two-year study on teacher leaders' roles by Elliot, Kazemi, Lesseig, Mumme, and Kelly-Peterson (2009), teacher leaders in mathematics were critical in facilitating collaborative PD. In this study, teacher leaders were provided with two frameworks to identify and produce math dialogue. Through socio-mathematical norms and the norms of mathematical reasoning, teacher leaders were able to construct a more focused plan for the group discussions, facilitate more purposeful mathematical conversations, and engage more teachers in the dialogue leading to increased teacher learning.

In sum, the empirical studies discussed in the previous sections provided evidence as to how reform-type PD models—such as collective teacher inquiry, participation in classroom-based research, and lesson study—have the potential to improve teaching and student learning in mathematics. The findings also revealed that these collaborative models reflect the structural characteristics that have been found by Birman and his colleagues and other studies (Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al.,

2007). The next section of this review will move into the structural and cultural factors that cut across these models.

Structural Factors: Birman's Framework

In their attempt to identify effective PD programs, Birman (2000) referred to the findings of 10 empirical case studies in five states with 1,000 teachers participating in the federally sponsored Eisenhower PD Programs. Teacher survey responses showed reform-type PD programs were effective and featured five characteristics of duration, active leaning, content, coherence, and collective participation. In a later study, Birman and co- researchers (2002) examined the PD activities of 207 teachers in 30 schools and in 10 districts in five states to understand the features of effective PD programs in the instruction of mathematics and science. The study selected one elementary school, one middle school and one high school in each of the 10 districts. The findings revealed that PD activities that had the most impact on teaching mathematics were reform and shared the same five common characteristics that were found in the previous studies. Theses common characteristics included an extended duration, active learning, content, coherence, and collective participation (Birman et al., 2002). These characteristics which are identified in other empirical studies as well (Jeanpierre, Oberhauser, & Freeman, 2005; Johnson et al., 2007; Penuel et al., 2007) will be will be referred as the structural conditions in this study.

While these studies have been important in identifying the structural conditions that support the collaboration of reform PD efforts, they have not attended to the important cultural factors that support or undermine the process. The success of

collaboration depends not only on the structural features, but also on cultural factors such as teacher efficacy and trust. The variation in the levels of teacher efficacy and trust in schools might influence the outcomes of teacher collaboration reflecting the same structural conditions (Fisher & Firestone, 2006).

The following section will describe each structural characteristic followed by the cultural factors and show how these factors cut across different models of collaboration. Further investigation of the cultural factors of teacher efficacy and trust will show how they influence the outcome of collaboration.

The Five Structural Characteristics of Birman's Framework. This framework will be used to provide a better understanding about the structural conditions of high performing collaboration in mathematics.

Duration. According to the findings of Birman and colleagues (2002), the duration of an effective PD program extends for a significant length of time, such as the entire school year. The span of time over which the collaborative activities take place should be long enough to provide teachers with sufficient time to focus on curriculum, student learning issues, and continuous evaluation of effective teaching strategies (Birman et al., 2002). Additional studies indicate that changes in teachers' knowledge and practice require collaborative activities that are spread out over the entire school year and provide teachers with opportunities to receive regular feedback on their teaching (Cohen & Hill, 2001; Joyce & Showers, 2002; Supovitz & Turner, 2000).

Active learning. According to Birman and colleagues (2002), the extent to which the activity offers opportunities for teachers to become actively engaged in the analysis of teaching and learning impacts the effectiveness of the activity in question. For example,

the collaborative activities of collective teacher-inquiry model and classroom-based research and lesson study offer teachers opportunities to collectively develop lessons, theories, and solutions for teaching and learning in mathematics. Teachers become active learners through ongoing feedback and reflection during these activities, leading to teaching improvement (Banilower & Shimkus, 2004; Boroko, 2004; Darling-Hammond, 1997). When teachers participate in classroom-based research, they self-regulate their own learning in the process of reflecting and revising their practice in collaboration with others becoming active learners (Butler, Lauscher, Selinger, & Beckingham, 2004).

Another example of the active learning influence can be seen in the teacher needs-based (TNB) model. TNB was designed to utilize a combination of activities such as collaborative work, teacher dialogue, hands-on activities, reflections, and self-monitored practice for middle-school mathematics teachers. Lee (2005) investigated the effectiveness of the TNB model on teachers' content and pedagogical knowledge. The findings indicated teachers changed their attitude regarding how students learn mathematics. They also showed an increased tendency to introduce innovative ways to teach mathematics, indicating increased confidence as well as an ability to adapt to alternative pedagogical strategies to assess student learning of mathematics (Lee, 2005).

Content. Birman and colleagues (2002) state that the degree to which the activity is focused on improving and deepening teachers' content knowledge makes a difference on the effectiveness of the collaborative activity in question. Teacher activities that focus on the content produce positive teaching outcomes. Teaching requires strategy and pedagogy, but it also requires knowledge of content and conceptual teaching on the identified subject area.

Recent reform efforts, such as those created by the National Council of Teachers in Mathematics (NCTM), have called for a shift in teaching from procedural, rules-based teaching to instruction that focuses on content, conceptual understanding, critical thinking, and problem solving. Although these reforms are well intended, teachers have not been provided with adequate training to adjust their thinking and teaching to meet these novel requirements (Brown & Benken, 2009). Studies of middle-school mathematics instruction reveal math teachers often focus on covering a range of material, relying on students' memorization abilities and technical skill development without conceptual underpinnings (Lieberman, 2009). This culture of teaching mathematics with a heavy focus on procedures inhibits the growth of students' critical thinking and problem-solving skills (Ball, Lubienski, & Mewborn, 2001).

There is a critical need for teacher activities that intentionally focus on content and pedagogy relating to increasing students' conceptual understanding of mathematics (Brown & Benken, 2009). Both teachers' mathematical content knowledge and pedagogy impact student achievement (Hill & Rowan, 2005); therefore, it is important to provide teachers with collaborative activities that focus on content, assisting them in meeting the new demands of teaching mathematics (Darling-Hammond, 2000). Collaborative activities that focus on content knowledge have been shown to increase teacher effectiveness and student achievement, particularly through focus on specific content curriculum (Cohen & Hill, 1998; Haycock, 1998; Joyce & Showers, 2002). Helping teachers to gain a deep understanding of content, and the way students learn that content, has been shown to be one of the vital dimensions of effective PD (Gusky, 2003).

Using data from the National Educational Longitudinal Study of 1988 (NELS),

Goldhaber and Brewer (1997) concluded that teachers with higher content knowledge in mathematics and science obtained higher student conceptual learning and performance than teachers who did not have strong content knowledge. Thus, teacher collaborative activities should be designed with a focus on improving teachers' content knowledge in their subject matter (Birman et al., 2002; Cohen & Hill, 1998); otherwise, teaching innovation becomes limited. To innovate, teachers should be provided with a deep content knowledge and a variety of pedagogical strategies (Lieberman, 2009).

Coherence. The next structural component of effective collaboration is coherence. Strong PD provides teacher collaborative activities that are coherent, consistent with teachers' goals, build on previous activities, and are followed by additional activities. These connected activities improve teaching practice and knowledge because they relate to teachers' everyday classroom instruction and pedagogy (Birman et al., 2000; Strahan & Hedt, 2009). Other empirical studies also show that effective teacher collaborative activities need to be ongoing toward specific instructional goals and objectives while providing opportunities to apply the new knowledge in classrooms (Desimone et al., 2002; Joyce & Showers, 2002). The activities of reform-type PD—such as PLCs, study groups, collective teacher inquiry, classroom-based research, and lesson study—are coherent because they build on previous activities and are followed by additional activities.

Collective participation. According to Birman and colleagues (2002), the degree to which the activity emphasizes the collective participation of groups of teachers from the same grade level teaching the same subject impacts the outcomes of the PD activity in question. Activities promoting collective participation provide teachers with

opportunities to discuss their new learning, common curricular materials, and shared goals for student achievement (Birman et al., 2002). The collective participation of teachers creates a powerful form of collaborative sharing of knowledge—leading to better teaching (Banilower & Shimkus, 2004; Borko, 2004; Desimone, 2009; Rosenholtz, 1989). Reform-type PD—such as PLCs, study groups, collective teacher inquiry, classroom-based research, and lesson study—are usually based on collective participation of teachers from the same grade level teaching the same subject.

In sum, Birman and colleagues (2002) found that reform-type PD activities featuring the five structural characteristics had the most impact on teaching mathematics. Although structural characteristics are important and play a significant role in the outcomes related to the collaborative activity in question, the role of cultural factors as they relate to individuals and groups must not be overlooked. Further investigation about effective collaborative activities must include the effect of cultural factors on their outcomes. Teacher efficacy and trust have been linked to increased collaboration (Bryk & Schneider, 2002; Hoy & Tschannen-Moran, 2003; Tschannen-Moran, 2001). Therefore, the investigation of these two constructs will enhance schools' chances of implementing successful collaboration in schools (Tschannen-Moran, 2001).

The next sections will unpack the two constructs and show their influence on the outcomes of teacher collaboration from a cultural vantage point.

Cultural Factors: Teacher Efficacy and Trust

While many studies have argued the impact of structural factors on collaboration (Birman et al., 2002; Gusky, 2002; Joyce & Showers, 2002), often the importance of the

cultural factors are missing. Smylie (1988) suggests teachers' efficacy and trust are important factors that influence changes in teaching practice as a result of PD. Pertaining to cultural factors, Fisler and Firestone (2006) assert teacher efficacy and trust influence teachers' willingness to collaborate with their colleagues. Interaction of teacher efficacy and trust affect the productivity of teacher collaboration (Chester & Beaudin, 1996; Esselman & Moore, 1992; Hoy & Woolfolk, 1993; Rosenholtz, 1989). The findings of Hoy and Tschannen-Moran's (1999) study showed that trust was positively related to teacher efficacy. The greater the degree of perceived trust was, the stronger the belief in teachers' ability to engage and implement a course of actions leading to success was. They also found that trust was a strong predictor of collaboration.

Based on the review of this literature, the structural variables that are needed for productive collaboration alone do not fully explain the variation that is found in the outcomes of teacher collaboration. The variation in teacher learning using the same collaborative model is influenced by other factors, such as teacher efficacy and trust (Fisler & Firestone, 2006). For example, in a study examining the impact of collaboration between teachers and university partners on teachers' professional development, teachers were all given the same opportunities for PD. However, there was a notable difference in their responses to those opportunities and in the degree of change in classroom practice. The findings revealed that the variation in the levels of teacher efficacy and trust among teachers contributed to the differences in teaching improvement in this collaborative model (Fisler & Firestone, 2006).

Regarding the relationship between teacher efficacy and collaboration, Shachar and Shmuelevitz (1997) claim that higher levels of teacher efficacy are associated with

improvement in teacher collaboration. Teacher efficacy is considered to be a strong predictor of the continuation of collaboration in reform PD programs and individual changes in teaching practice (Chester & Beaudin, 1996; Hoy & Woolfolk, 1993; Smylie, 1988). Teacher efficacy has been linked to teachers' instructional experimentation facilitated by collaboration, including the willingness to try a variety of materials and approaches, the desire to improve teaching, and implementation of progressive and innovative strategies (Berman, McLaughlin, & Guskey, 1988; Smylie, 1988; Stein & Wang, 1988).

The decisions teachers make about working with others and improving their teaching are directly influenced by their sense of efficacy. The higher teachers' sense of efficacy, the more likely they are to overcome obstacles associated with working with others. With higher efficacy, teachers develop persistence to overcome the problems that may be associated with working collaboratively. Such resiliency, in turn, tends to produce more positive outcomes and foster more innovative teaching resulting from work with other teachers (Goddard, Hoy, & Hoy, 2004). The following sections will further explain teacher-efficacy beliefs and trust, followed by a number of empirical studies illustrating their impact on collaboration.

Teacher-Efficacy Beliefs. Perceived self-efficacy is a person's judgment about his or her capability to perform a specific task (Gist & Mitchell, 1992; Goddard & Hoy, 2004). As self-referent perception of capability to perform a specific task, individual efficacy beliefs are predictors of individual behavior (Pajares & Miller, 1994).

Teaching efficacy is the belief that a teacher holds about his or her ability to make a positive change in teaching behavior. Teacher-efficacy belief affects the amount of

effort that a teacher will put into working with other individuals and the persistence that a teacher will show in the face of obstacles. Teachers' sense of efficacy has proven to be a powerful force in teacher behaviors related to collaboration, effort, and persistence (Berman & McLaughlin, 1978). Teaching improvement is more likely to occur in schools rich in individual and collective efficacy (Daly & Chrispeels, 2005).

Empirical studies have shown that the relationship between teacher efficacy and collaboration is reciprocal; efficacy affects the outcomes of collaboration, and collaboration influences perception of self-efficacy in teachers. For example, the outcomes of a study done in urban schools of nine school districts and 173 teachers illustrated the influence of collaboration on teacher efficacy. The findings suggested that the opportunities for collegial interaction and collaboration that were provided by schools influenced teachers' feelings of efficacy and empowerment. Teachers in schools that perceived high degrees of collaboration among teachers reported a higher change in self-efficacy than those who taught in schools with little opportunity for collaboration (Chester & Beaudin, 1996). Another study from 3,074 teachers in 218 elementary schools examined the effects of teacher efficacy on teacher commitment to school mission and sustained collaboration. The findings suggested that teacher efficacy was a strong predictor of teacher commitment to the collaboration (Ross & Gray, 2006).

A similar investigation of phenomenological case studies done by Lantner (2003) examined five elementary teachers' perceptions of personal teaching efficacy, empowerment, and collaboration. Participants involved in this investigation taught in a collaborative and empowered school setting. The teachers in this study stated that organizational opportunities for decision making and high-quality collaboration

contributed to their perceptions of empowerment, leading to an elevated sense of self-efficacy. Teacher efficacy was related to collaboration through the power of shared resources, particularly information and ideas. The findings of this study suggested that there is a reciprocal relationship between self-efficacy and the degree to which teachers collaborated with their colleagues (Lantner, 2003).

Teacher efficacy, in turn, is influenced by school's culture of collective efficacy (Goddard & Hoy, 2004). The behavior of individuals in organizations is influenced by their beliefs about group capability (Bandura, 1986; Raudenbush, Rowan, & Cheong, 1992; Sampson, Morenoff, & Earls, 2000). Collective efficacy perceptions have power to transfer high expectations to the group and encourage members to reach school's high expectations and produce positive outcomes. Collective beliefs are teachers' judgments about their own capabilities as a group to plan and implement the course of actions that are required to produce specific goals in specific context (Goddard & Hoy, 2004). A strong sense of collective efficacy enhances teachers' self-efficacy beliefs while weak collective efficacy beliefs undermine teachers' sense of efficacy (Goddard et al., 2004). As is claimed by Bandura's (1997) social cognitive theory, social influence shapes self-efficacy beliefs. That is, where teachers tend to think highly of the collective capability of the faculty, they sense an expectation for successful teaching. This elevated sense of expectation for success affects the diligence with which teachers choose to pursue their goals (Sampson et al., 2000), leading them to put forth the effort required to achieve schools' goals of enhanced teaching and higher student learning. On the other hand, when perceived collective efficacy is low, it is less likely that teachers will be pressed by

their colleagues to persist in the face of challenges or that they will change their teaching when students do not learn (Goddard et al., 2004).

A robust sense of collective efficacy particularly impacts self-efficacy of new teachers. When teachers are new to a school, they learn about the school's culture in interactions with other teachers and administrators. In schools possessed by a high degree of perceived collective efficacy, new teachers learn that extra effort and student success are the norm. In turn, these high expectations for action create a normative press that encourages all teachers to do what it takes to succeed and discourages them from giving up when faced with difficult obstacles (Hoy & Woolfolk, 1990). Hence, the expectations for action set by collective efficacy beliefs influence teachers' performance (Parsons, 1951).

In a school characterized by a high level of perceived collective efficacy, the faculty might condemn the behavior of a teacher whose actions are inconsistent with group's expectations (Coleman, 1985, 1987, 1990). A good example of this phenomenon was documented by Skrla and Goddard (2002), who studied collective efficacy beliefs in schools with a student population characterized by a majority of Hispanic students. During the interview process, one teacher stated that most teachers do whatever it takes to reach the school's goal and "if you hear a teacher that may not be quite there, I believe that by the time they hang around, either they will be there, or they'll be out the door" (Skrla & Goddard, 2002, p. 17). Such a comment suggests that school's norms, which are collective expectations for teacher's behavior and actions (Coleman, 1985), have a strong influence on individual teachers and have power to exert pressure and persuade teachers to behave and act in certain ways (Bandura, 1997).

Further empirical studies have provided evidence that schools' perceived collective efficacy influences teachers' sense of efficacy (Hoy & Woolfolk, 1993; Moore & Esselman, 1992). Analysis of data collected from 438 teachers in 47 schools in a large urban school district examined whether perceived collective efficacy was positively related to differences among schools in teachers' sense of efficacy. The findings indicated that the variation between schools in teacher efficacy might be explained by the collective efficacy of a school. Teacher efficacy was higher in the schools where collective efficacy was higher. When the effect of other contextual variables—such as school's socioeconomic status and prior achievement—was considered, collective efficacy was the only significant predictor of teacher efficacy differences among schools (Goddard & Goddard, 2001). These findings indicate that perceived collective efficacy beliefs have a stronger impact on teachers' perceptions of self-capability than other contextual variables. Moreover, these findings suggest that collective efficacy beliefs may influence student achievement indirectly through their relationship with teachers' sense of efficacy (Goddard & Goddard, 2001).

The following sections will explore the other cultural condition, trust in schools, and the relationship between trust and efficacy beliefs and how together they might impact the outcomes of collaboration in schools.

Trust. Willingness to collaborate and participate in productive teamwork depends on individual's trust in others and perceived trustworthiness (Brown, Scott, Poole, & Rodgers, 2004). Trust is a critical component of schools' success (Daly, 2009).

Trust, as defined in this study, refers to the work of Daly (2009) and Hoy and Tschannen-Moran (1999) who define trust as a multifaceted construct. Hoy and

Tschannen-Moran define trust as "an individual's or group's willingness to be vulnerable to another party based on the confidence that the latter party is benevolent, reliable, competent, honest and open" (p. 204). Hoy and Tschannen-Moran (1999) state that in all trust relations there are five aspects—benevolence, reliability, competence, honesty, and openness—which are referred to as "five faces of trust" (p. 186). It is important to define trust as a multifaceted construct as this definition provides a better understanding of the potential trust (Daly, 2009). The multifaceted definition of trust could identify which individual facets have the most influence on the subject of study. For example, the findings of a study investigating the relationship between trust and leadership revealed that the facets of respect, risk, and competence had the highest relationships with leadership (Daly & Chrispeels, 2008). The findings of another study revealed teachers who worked in schools that continued to keep their program improvement status reported less integrity and risk taking (Daly, 2009), leading to less trust in those schools.

The strength of collaborative mathematics models—such as collective teacher inquiry, participation in classroom-based research, and lesson study—discussed in the previous sections could be linked to the existence of the five faces of trust. For example, in lesson study model, teachers observe each other teaching a lesson that was jointly developed. The benevolence aspect of trust is the confidence that one's well-being will not be harmed by the trusted party—even when the opportunity is available (Hoy & Tschannen-Moran, 1999). Teachers would be more willing to participate in the observation process with the benevolence aspect of trust. Sense of benevolence (Baier, 1986; Butler & Cantrell, 1984; Cummings & Bromily, 1996; Daly, 2009; Mishra, 1996) has the potential to increase individuals' willingness to be open to criticism and become a

more active participant of collaborative activity. Benevolence aspect of trust helps teachers to accept vulnerability to their peers with the expectation that there would be no ill will (Baier, 1986).

Reliability—another aspect of trust, which is the extent to which one can count on another individual to provide what is needed (Hoy & Tschannen-Moran, 1999)—has the potential to strengthen the outcomes of collaborative work. For example, if teachers feel they can rely on their research partners for assistance regarding all matters in an inquiry model, the outcomes of their joint work could be strengthened. Lesson study is another example of collaborative model and requires teachers to rely on each other's knowledge while developing lessons, analyzing student work, and improving teaching (Lewis et al., 2006). Lesson study model could benefit from another feature of trust, competence, which is the degree the trusted party has knowledge and skill (Hoy & Tschannen-Moran, 1999). Teachers might find more value in lesson study work when they feel they are being observed and getting feedback from peers who are competent and equipped with knowledge and skills.

Openness, another aspect of trust, is the process by which people make themselves vulnerable by sharing information with others (Daly, 2009; Hoy & Tschannen-Moran, 1999). The effectiveness of mathematics collaborative models—such as collective teacher inquiry, which focuses on promoting a learning inquiry in which participants question their teaching and share information (Potari et al., 2010)—depends on participants' openness. With this aspect of trust, teachers become transparent and honest about the problems they may experience in their classrooms, showing more willingness to conduct discussions with others in search of solutions.

Integrity, which is the fifth facet of trust, is defined as individuals' acceptance of responsibility for their own actions (Daly, 2009; Hoy & Tschannen-Moran, 1999). From this perspective, in order for collaborative models such as collective inquiry model to be productive, teachers need to perform an honest assessment of their own teaching and avoid distorting the truth in order to shift blames to others. With the true identification of problems, mathematics teachers might be able to work with others, find solutions, and improve their teaching. Trust as confidence in the reliability, integrity, and social relations of individuals in a group has potential to nourish or inhibit effective collaborative work (Coleman, 1990; Rosenholtz, 1989; Smylie, 1995). When these facets of trust are present in mathematics teachers' relationship with one another, they may become more productive than a similar group that lacks trust.

An empirical study of 690 professional athletes examined team performance as influenced by trusting relationships among the players. The findings indicated that high level of trust was related to high degree of teamwork and better performance for the team (March, Dolan, & Tzafrir, 2010). The important link between trust and high level of teamwork that has been found in other organizations holds true in educational settings as well.

The findings of a study done by Park and Henkin (2005) in three elementary schools and one middle school in a single district located in the southeast United States suggested that trust was an important element in teachers' teamwork behavior and the effectiveness of collaboration (Park, Henkin, & Egley, 2005). The trusting behavior of team members played a critical role in predicting teachers' commitment to teamwork. Those teachers showing higher levels of trusting behaviors perceived higher levels of

team commitment, resulting in a higher degree of collaboration (Park et al., 2005). The findings of this study confirm the notion that trust is an important foundation for productive group relationships, teamwork, and successful collaboration (Baier, 1986).

Another finding of a 39-item collaboration survey of 50 teachers from six states revealed that trust was a significant predictor of collaboration among teachers within schools (Tschannen-Moran, 2001). In schools where there was greater trust, there tended to be a greater level of teamwork and collaboration. However, when trust was absent teachers were more reluctant to work closely together as teams and collaboration was more difficult.

Collaboration requires intensive interaction and cooperation that can be strengthened with trust (Brown et al., 2004). For teachers accustomed to working in isolation, the uncertainty inherent in collaborative work is likely to raise doubts that may constrain interactions and collaboration, and trust might mitigate such constraints. Effective teacher collaboration requires that teachers participate with a willingness to open themselves to their peers and cooperate in accomplishing the same goal, finding solutions and learning from each other (Brown et al., 2004). The extent to which teachers collaborate, observe each other, provide feedback, and share information about their classrooms—all involving risk for teachers—depends on the existence of social trust (Boles & Troen, 1997; Coleman, 1990). In schools with a weak culture of social trust, teachers are less likely to collaborate, share problems, observe each other, and provide feedback—all of which are important to the success of mathematics collaborative models such as teacher inquiry, classroom-based research, and lesson study as discussed in previous sections.

In order for teachers to open their classrooms and share problems, they would have to make themselves vulnerable and show willingness to take risks, which is one of the aspects of trust. Mayer, Schoorman, and Davis's (1995) definition of trust involves revealing our vulnerability to other individuals. Trust is the willingness to take risk and the level of trust is an indication of the amount of risk that one is willing to take (Schoorman et al., 1995). When trust is defined as a willingness to be vulnerable to another party, it becomes necessary to assess the degree to which a truster is willing to voluntarily take risks at the hands of the trustee (Schoorman et al., 2007).

In the mathematics collaborative models—such as collective teacher inquiry, participation in classroom-based research, and lesson study—teachers observe each other's teaching, express their problems, and share information about what they are doing in their classrooms making themselves vulnerable to criticisms from their peers. From this perspective, trust helps teachers to manage the uncertainty and risk associated with opening up to their peers and jointly optimizes the gains that will result from their cooperative behavior (Jones & George, 1998). Without trust, it becomes difficult for mathematics teachers to engage in the collaborative activities of reform PD, open up their classrooms, take risks, and make themselves vulnerable to their peers.

The absence of trust in schools has been linked to teacher anxiety and isolation (Daly, 2004; Tschannen-Moran, 2004). The findings of a study done by Fisler and Firesone (2006) showed that the lack of trust among teachers created an environment in which teachers were isolated and did not go observe each other's classrooms unless they had a specific assignment. They also did not show willingness to share their ideas, instructional strategies, or teaching struggles with one another due to lack of trust.

Within the overall climate of distrust, teachers in the school differed significantly in their levels of trust of others in the partnership (Fisler & Firesone, 2006). This study illustrates how distrust might undermine productive interaction, discourage open exchange, inhibit cooperation, and limit opportunities for teaching improvement during mathematics collaborative activities.

In support of the influence of trust, Costa (1995) states collaboration cannot be successful without mutual trust within the group members. If the goal is to use collaboration to increase teaching effectiveness, there must be a high degree of trust and respect for each other (Costa, 1995). When teachers trust their colleagues, they feel safe to confide in each other, esteem each other's opinions or statements, take chances, and succeed or fail without decreasing their sense of self-worth. Without mutual trust it becomes a real challenge to have effective collaboration (Lovell & Wiles, 1983).

The findings of an investigation between teacher collaboration and trust revealed that trust among participants was a prerequisite to effective collaboration, and that without trust and respect collaboration was futile (Costa, 1995). Those who established the most energetic and effective collaborative relationships shared common beliefs, such as understanding that collaboration must be nonthreatening, nonevaluative, open, honest, and include reliance (Costa, 1995).

Jones and George (1998) provide another perspective on how trust might influence collaboration. They state that trust facilitates the development of a cooperative behavior, which is a critical element of collaboration. The development of a cooperative behavior includes a number of behaviors, such as flexibility, confidence in others, seeking help when needed, sharing knowledge, having a high level of involvement, and

letting go of personal egos. These behaviors mark trust as an important factor in collaboration (Jones & George, 1998).

In summary, the findings of a number of studies indicated that a high level of teacher efficacy and trust was related to high degree of collaboration in schools (Bryk & Schneider, 2002; Daly, 2004; Tschannen-Moran, 2004). The studies in the previous sections showed a link between the structural factors and strong collaboration. This study proposes a model that links the collaboration component of reform-type PD to a combination of structural and cultural factors.

Proposed Model

Birman and colleagues (2002) found effective PD programs are based on reform PD and feature five structural characteristics. Based on the review of this literature, the structural variables solely do not fully explain the variation that is found in the outcomes of teacher collaboration in different types of reform PD. The variation in teaching improvement using the same collaborative model is influenced by cultural factors such as teacher efficacy and trust (Bryk & Schneider, 2002; Fisher & Firestone, 2006). Although structural factors are important and play a significant role in the outcomes related to the collaborative model in question, the role of cultural factors as they relate to individuals and groups must not be overlooked.

While there have been numerous studies connecting structural factors and collaboration of reform PD (Birman et al., 2002; Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al., 2007) and studies connecting cultural factors and collaboration (Bryk & Schneider, 2002; Daly, 2004; Hoy & Tschannen-Moran, 2004; Tschannen-Moran,

2001), there are only a limited number of studies that bring together both structural and cultural factors on understanding the collaboration component of reform PD in mathematics.

This study proposes a model (Figure 1) that can bring cultural and structural conditions together and help us to better understand the supportive conditions of high performing collaboration. This inquiry will explore the interaction of cultural conditions of teacher efficacy and trust s with the structural conditions of duration, active learning, content, coherence and collective participation.
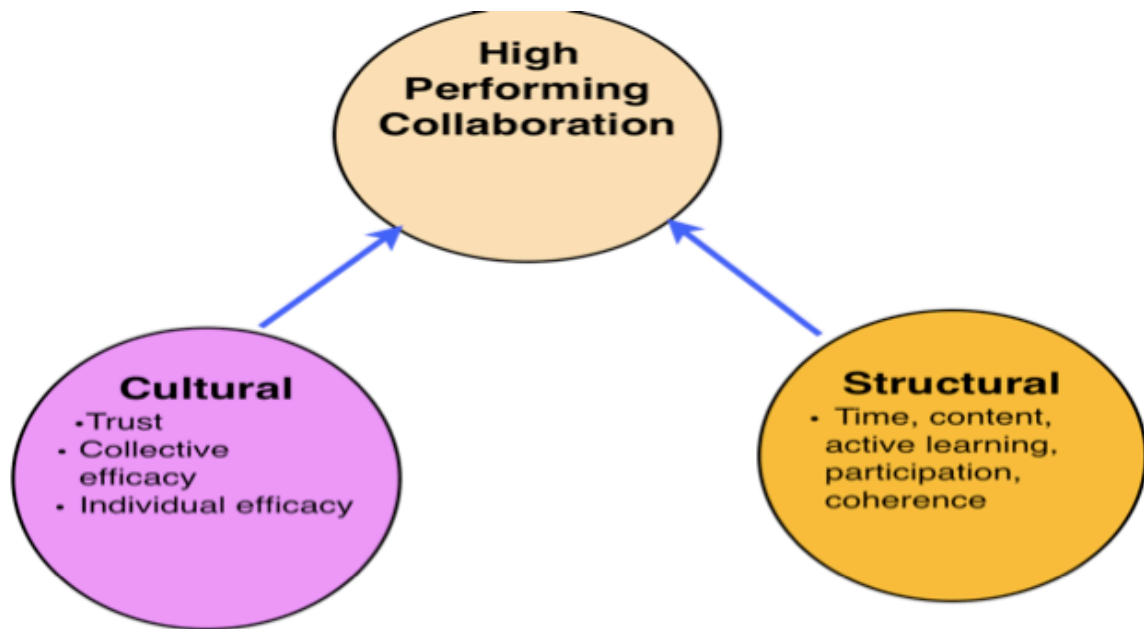
Figure 1. Proposed Model

To provide a more detailed description of the proposed model, Figure 1 illustrates the intersection of the research questions, frameworks, and methods used in this study. The research questions are:

1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?

2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?

3. What are teachers' perceptions of collaboration and its influence on their teaching?

All three questions are informed by the five structural characteristics—extended duration, collective participation, active learning, coherence, and focus on content (Birman et al., 2002; Jeanpierre et al., 2005; Johnson et al., 2007; Penuel et al., 2007). Additionally, in relation to efficacy, the research questions are informed by the work of Goddard and colleagues (2004). The work of Daly (2009) and Hoy and Tschannen-Moran (1999) provide a frame for the investigation of trust.

Table 1. Research Scaffold Composed Of Research Questions, Frameworks, And

Methods

Research Question	Framework	Method
1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?	Birman and colleagues' (2002) five structural features. Goddard and colleagues' (2004) individual and collective efficacy. Daly (2009) and Hoy and Tschannen-Moran's (1999) five faces of trust.	Quantitative and qualitative investigation of structural and cultural factors of collaboration.
2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?	Birman and colleagues' (2002) five structural features. Goddard and colleagues' (2004) individual and collective efficacy.	Quantitative and qualitative investigation of structural and cultural factors of collaboration.
3. What are teachers' perceptions of collaboration and its influence on their teaching?	Daly (2009) and Hoy and Tschannen-Moran's (1999) five faces of trust.	Quantitative and qualitative investigation of structural and cultural factors of collaboration.

The framework of five structural features provides the lens through which the data

collection and analysis will be conducted. Duration requires the researcher to identify the

activities of longer duration, both in time span and in contact hours. Duration will also

help identify whether teachers collaborate within the provided time or a combination of

provided time and their own time. Coherence will help the researcher to see whether the

collaborative activities are planned and consistent with teachers' goals and support

national, state, and district standards and assessments. Collective participation will

identify the capacity of teachers from the same subject and the same grade level to share

knowledge and learn from each other. Active learning will help the researcher to see whether teachers visit each other, provide feedback, and share student work. Content will help the researcher to see if the activities involve specific content-based goals.

The work of Goddard and colleagues (2004) provides the lens through which the link between the individual efficacy and collective efficacy is made. Finally, the work of Daly (2009) and Hoy and Tschannen-Moran's (1999) five faces of trust will provide a lens through which trust will be analyzed as a multifaceted construct including benevolence, reliability, competence, honesty, and openness—referred to as the "five facets of trust" (p. 186).

In the next chapter, the proposed study's methodological approach will be explained. The framework for this methodology is constructed from a combination of the stated frameworks to explore the structural and cultural conditions of collaboration in mathematics.

Chapter Three: Methodology

In the first chapter, the critical need for effective collaboration in mathematics was established. The need to document, describe, and analyze the conditions of successful collaboration that could improve teaching mathematics was highlighted. The second chapter reviewed literature on the structural and cultural conditions of collaboration in reform PD. While the literature showed numerous studies that connected structural factors and collaboration and studies that linked cultural factors to collaboration, only a limited number of studies connected the combination of these conditions to collaboration. This study investigated the connection between both sets of conditions and mathematics teachers' collaboration by examining two high performing cases of collaboration. This chapter will explain the research design methodology used to explore the supportive structural and cultural conditions that exist in high performing cases of collaboration and address the research questions.

Purpose of the Study

The primary goal of this study was to explore the structural and cultural conditions that support or constrain middle-school mathematics teachers' collaboration using illustrative case studies. This unique study investigated both structural and cultural conditions and their relationship in a new way to better understand effective collaboration in mathematics. Furthermore, this study investigated teachers' perception of collaboration and its relationship to their teaching.

After reviewing the literature on the factors impacting the outcomes of teacher collaboration, the evidence indicated that both structural and cultural factors are key

players in successful collaboration of reform PD program efforts. However, there is limited research on the impact of structural and cultural factors combined on the outcomes of teacher collaboration in mathematics. This study explored how the structural factors of duration, coherency, content, active learning, and collective participation and the cultural factors of collective efficacy, individual efficacy and trust support or constrain mathematics teachers' collaboration through the research questions guiding this study.

Research Questions

1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?

2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?

3. What are teachers' perceptions of collaboration and its influence on their teaching?

Design of the Study

The research design of this project was "mixed methods research" study (Yin, 2003, p. 62), which was also a sequential study (Creswell, 2008) combining quantitative and qualitative research techniques into a single study (Johnson & Onwuegbuzie, 2004). This design (Figure 2.) used a two-case study model using both surveys and interviews. The study employed a survey on structural and cultural conditions to identify the existing supporting or constraining conditions in four middle schools in two participating districts. The findings of the survey guided the selection process of two sites that showed the

highest performing collaboration in mathematics and an illustrative case study model was conducted (Yin, 2003) to answer three research questions. Yin (2003) describes case study as an appropriate strategy when the research questions focus on "what" questions (p. 9). The research questions in this study focus on exploring the structural and cultural conditions necessary for effective collaboration in mathematics. Hence, the type of questions in this study is a justifiable rationale for conducting an exploratory study (Yin, 2003). Since surveys provided limited opportunity to investigate the structural and cultural conditions in depth, the interview phase helped to further investigate those conditions that influence the collaboration outcomes and the constraints (Yin, 2003).

In order to "understand phenomena deeply and in detail" (Morse, 2007, p. 30) data were collected from surveys and interviews. The survey provided quantitative information about the two districts and helped the study to select two cases with high performing collaboration. This type of selection is in line with a strengths-based approach, providing the researcher with an opportunity to explore, affirm, and illuminate the structural and cultural conditions involved in successful collaboration (Cooperrider & Srivastva,, 1987). A cross-unit analysis further investigated the structural and cultural conditions of these two successful collaborations and determined whether these two instructive cases of collaborations share similar structural and cultural conditions (Yin, 2003).
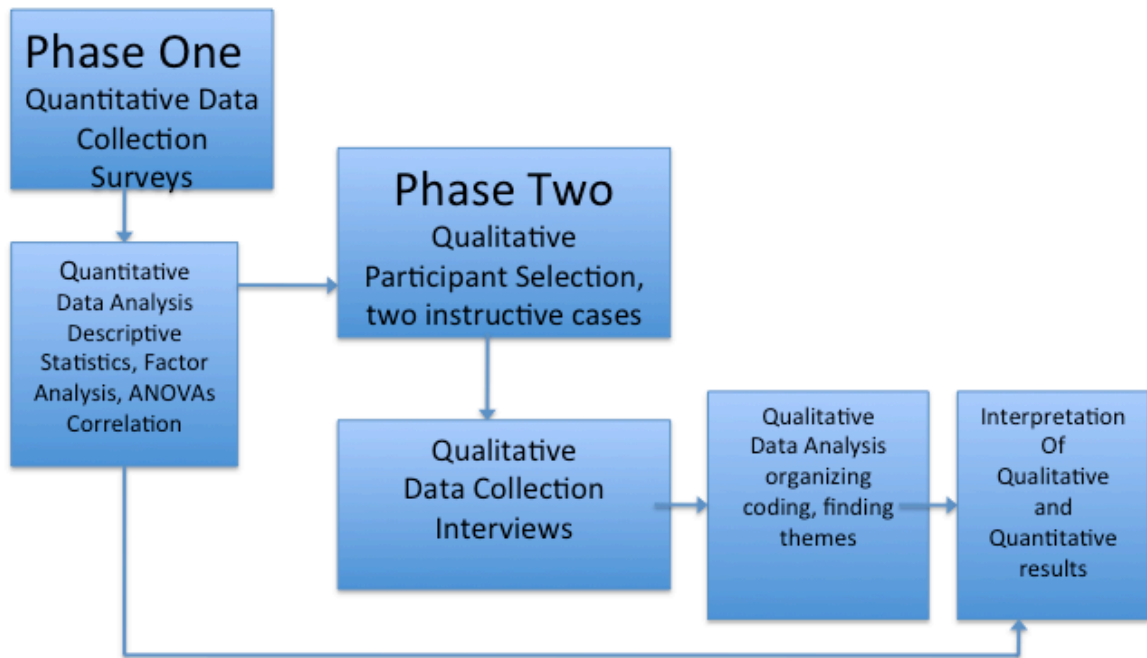
Figure 2. Methodology Design: Mixed Methods

Context: Site Selection

Since the case study design was selected, it was important to select the most

appropriate sampling (Merriam, 1998). For this study, two districts that serve high

populations of traditionally marginalized students were purposefully selected. Both

districts serve more than 45% Latino, around 3% Black, and more than 35%

socioeconomically disadvantaged students. This selection allowed the researcher to

maximize her knowledge on the topic of the study and address the purpose of research

questions (Patton, 1990). Within these two districts, the findings of the quantitative data

were used to select two cases with the highest performing collaboration using a strengths-

based approach, and these two cases were referred to as two instructive cases. These two

instructive cases of collaboration helped us to better understand the conditions that lead

to superior performance and reinforce the conditions that exemplify high performing

collaboration in mathematics (Bushe, 1995). Organizations that attempt to appreciate

their best quality will discover more about their best quality (Cooperrider & Srivastva

1987).

Both districts are located in San Diego's North County. District A is comprised

of 11 elementary schools, three middle schools, and two high schools and serves 13,322

K-12 students. The ethnic breakdown of the students in this district is as follows: 48%

Latino, 39% White, 8% Asian, 3% Black, and 2% other. Thirty-six percent of the

students are considered socioeconomically disadvantaged, 25% are English-language

learners, and 17% are Gifted and Talented Education (GATE) students.

District B is comprised of 17 elementary schools and five middle schools serving

14,077 K-8 students. The ethnic breakdown of the students in this district is as follows:

68% Latino, 22% White, 6% Asian, 3% Black, and 1% other. Sixty-six percent of the

students are considered socioeconomically disadvantaged, 48% are English-language

learners, and 11% are GATE students.

A Two-Phase Study

This study was conducted in two phases. The first quantitative phase facilitated

the collection of data from a survey that included questions on both the structural and

cultural conditions and teaching practice construct in middle schools of both districts.

This survey data was used as a way to select two schools with the highest performing

collaboration and to evaluate teachers' perception of their collaboration and their

teaching practice. The two sites, which were similar and had the highest average scores

for most constructs including structural, cultural and teaching practice constructs, were selected for a further in-depth, illustrative case study.

It is important to note that this study included two separate quantitative and qualitative phases because the quantitative phase primarily was used as a sampling strategy. In addition, the data in the quantitative phase was analyzed and used to identify general findings about collaboration in the two high performing schools and use the qualitative phase to gain a deeper understanding about collaboration in these two schools.

Once the sites were selected, the second phase used interviews to help us explore in depth the conditions that make these two collaborations successful and address the research questions. Rudestam and Newton (2007) state that the mixed methods approach "combines the rigor and precision of experimental, quasi- experimental, or correlation designs and quantitative data with the depth understanding of qualitative methods and data. Thus, the methods can help inform one another or deal with different levels of analysis" (p. 51). The next sections will unpack both the quantitative and the qualitative phases, including four main sections: participants, data collection methods, procedures, and data analysis.

First Phase: Quantitative Survey. This study used a survey instrument that included 47 questions on the structural, cultural and teaching practice constructs that exist in middle schools of both districts (see Appendix A). This instrument used items from Survey of Teachers Participating in Eisenhower-Assisted Professional Development Activities (1998) to identify and measure the structural factors of duration, content, coherence, collective participation, and active learning. Additionally, the survey used some items from the Omnibus T-Scale of Hoy and Tschannen-Moran (2003) to measure

trust construct, as well as items from Goddard and Hoy's (2003) Collective Efficacy-Scale to measure collective efficacy. The survey also included some items from Tschannen-Moran and Hoy's (2001) short scale to investigate individual efficacy. Additional questions on this survey instrument identified teachers' perception of their collaboration on their teaching practice. The responses from the survey helped this study to address the research questions and identify two high performing cases of collaborations for the interview phase.

Participants. The quantitative phase of the study included invitations to all 6th, 7th, and 8th grade mathematics teachers and administrators from one middle school in district A, and three middle schools in district B. Both districts are moderate sized located in Southern California. I purposefully selected these two districts because they both serve high populations of traditionally marginalized students. Both districts serve around 45% Latino, 3% Black, and more than 35% socioeconomically disadvantaged students. All three middle schools in district A participated. Only one school in district B was invited to participate based on the suggestion made by the superintendent of this district.

Table 2 represents the participating schools, the number of participants including teachers and administrators, the number of survey response returned and each site's response rate percentages usable. As table 2 indicates, the overall average return rate of 92% among participants at all the middle schools was consistent with the return rate at each middle school. Two schools had a usable return rate in 90% range and one of the middle schools returned 100% of the surveys.

Table 2. Average Survey Response Rate

Schools	Number of Teachers and Administrators	Number of surveys returned	Percentage Returned/Used
1	12	12	100%
2	11	10	91%
3	13	12	92%
4	15	13	87%
Total	51	47	92% (Average)

Data Collection Methods.

The first phase of the study, which was quantitative, used the survey instrument to provide a general understanding about the three research questions and identify two instructive cases of collaboration in two districts. First, this phase addressed the first research question and helped us to identify the structural and cultural conditions that occur in high performing cases of collaboration. Second, it addressed the second research question and helped the study to identify the positive correlations between teaching practice, structural and cultural conditions. It also addressed the third research question pointing to a positive correlation between teaching practice (TP), structural and cultural conditions. Lastly, the mean scores of structural, cultural and teaching practice constructs were used to make a comparison between all schools and select two high performing cases for the interview phase.

I administrated the surveys during math meetings to increase response rates. The survey measured the extent to which structural and cultural conditions exist from administrators and mathematics teachers' perceptions. There was one survey instrument that was a modified version of multiple instruments reflecting questions on both structural and cultural factors. The instruments—Teachers Participating in Eisenhower-

Assisted Professional Development Activities (1998), Omnibus T-Scale of Hoy and

Tschannen-Moran (2003), Short form of Collective Efficacy Scale of Goddard and Hoy

(2003), and short form of Teacher Efficacy Scale of Hoy (1990)—were used because

they are more established and reported reliability is higher. The survey had five

demographic questions and 47 items (Likert scaled, six-point scale). Appendix A has an

image of the survey.

Structural and cultural conditions and teachers' perceptions of collaboration and

its influence on teaching were measured with 19 questions from Teachers Participating in

Eisenhower-Assisted Professional Development Activities (1998), five questions from

Omnibus T-Scale of Hoy and Tschannen-Moran (2003), seven items from Goddard and

Hoy's (2003) Collective Efficacy, and six items from Hoy's (1990) teacher efficacy. The

survey also included 10 questions from Teacher Perception and Influence on their

Teaching of Monro Township School District PD evaluation Survey (2005) to capture

teachers' perception of collaboration and its influence on their teaching.

The items were scored on a six-point scale, ranging from 1 (strongly disagree) to

6 (strongly agree). After the surveys were analyzed, two high performing cases with the

highest average for most constructs including structural, cultural and teaching practice

constructs were selected for the qualitative phase of the study.

Survey administration procedures. The surveys were administered and collected

in person during math meetings to the administrators and 6th, 7th and 8th grade

mathematics teachers in one middle school in district A and three middle schools in

district B. All participants were asked to complete the printed surveys. The instrument

included a letter informing the participants about the purpose of the study, the time

required for survey completion, their rights not to participate, privacy policy, and how their anonymity will be protected. At the end of the letter, voluntary participation was requested. During each meeting, after the participants completed the surveys and signed their consent, data were collected and placed in envelopes. Appendix F has an image of survey consent letter.

   Data Analysis. A survey instrument, which included 47 questions on the structural, cultural and teaching practice constructs was used to identify the supportive conditions of high performing collaboration and teachers' perception while measuring these conditions to select two high performing cases for the interview phase.

   The data from the surveys were coded and entered into SPSS. To analyze the quantitative data, answer the research questions, and select two high performing cases of collaboration for the interview phase, a variety of statistical analyses were conducted including descriptive statistics, factor analysis, Pearson correlation tests and ANOVA tests. All of the statistical procedures were conducted using the statistical package SPSS 17.0 for Mac. The range of these statistical tests allowed me to analyze the data in depth. Descriptive statistics analysis was used to describe, summarize, and report the overall sample. Since the research sample includes teachers from all middle schools in two districts, it was necessary to use descriptive statistics to obtain information such as mean, median, minimum, and maximum concerning each structural cultural and teaching practice construct for each school and each grade level. This analysis helped the study to identify two cases with the highest average scores and high performing cases of collaboration.

   Although items under each construct of the survey have previously been tested for

validity for use within educational settings, a Confirmatory Factor Analysis (CFA) was

performed as recommended by Antonakis et al., (2003) to ensure all the items of each

individual structural and cultural construct loaded on the identified construct. A scree

test and an eigenvalue of 1.0 were used to determine the number of components. Items

with factor loadings of 0.4 or higher on single component were used to define the

construct. In addition, reliability was tested by the Cronbach's alpha measure (α).

Cronbach's alpha is a coefficient of internal consistency of the items of the scale. The

field of social science suggests a reliability coefficient of 0.7 and above to be considered

"acceptable" (Szklo & Nieto, 2000; Klein, 1999). It is important to note that such general

guidelines need to be used with caution because reliability coefficient depends on the

number of items on the scale.

It was also important to determine the presence of a relationship between

structural, cultural and teaching practice constructs in response to the second research

question. Pearson correlation analysis showed whether there was a positive, negative or

no relationship between the structural, cultural and teaching practice constructs.

Finally the individual ANOVAs were ran to identify the differences between four

schools by comparing the mean scores of teaching practice, structural and cultural

constructs for 6th and 7th/8th grades at four schools. The use of ANOVA test was justified

here because the required assumptions of normal distribution of data, independence of

cases, and equality of variance (each group's variance is equal) were met. This test

helped me to compare the average scores and aid the case selection. A 4X2 between-

factor ANOVA (four schools and two grade teams) was applied to each confirmed

construct. The evaluation of grade level on each of the construct measures was done by

grouping 7th and 8th grade teachers. This was done since the majority of the 7 and 8th

grade teachers taught both 7th and 8th grade math; hence the comparison for grade was

between two rather than three groups. The resulting 4X2 ANOVA used the between

factors SCHOOL (1,2,3,4) and GRADE (6, 7/8). The patterns of performance on the

various scales were used to differentiate both school and grade level team.

It is important to note that the surveys data were parametric data because they

were measured using a 6-point response scale. Therefore parametric analysis was

conducted on parametric data showing normal distributions.   Table 3 shows the data

analysis used to address the research questions and selection of two high performing

cases for the interview phase.

Table 3. Research Methodology for Quantitative Research Questions

Purpose	Data Analysis
Address research question 1 1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?	Descriptive Statistics, Factor Analysis
Address research question 2 2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?	Pearson Correlations
Address research question 3 3. What are teachers' perceptions of collaboration and its influence on their teaching?	Descriptive Statistics, Pearson correlation
Select two instructive cases of collaboration	ANOVA tests

Second Phase: Qualitative Interviews

The quantitative phase helped this study to select two instructive cases of

collaboration and conduct the qualitative phase. Although there were some variations in

these two cases, they were both treated as one case of high performing collaboration reflecting similar conditions for the following reasons: 1. Both cases reflected middle school settings and the same grade levels. 2. Both cases scored high on the average of most structural and cultural constructs and teaching practice. 3. The quantitative phase showed that teacher responses in these two schools were similar.

In order to "understand phenomena deeply and in detail" (Morse, 2007, p. 30) data were collected from interviews with teachers and administrators at two instructive cases of collaboration. The interviews provided a deeper understanding about the structural and cultural conditions of high performing cases of collaboration and the ways these conditions interact with each other. This phase resulted in the development of more powerful explanations for the conditions that support the process of collaboration in high performing cases (Miles & Huberman, 1994).

Participants. Purposeful sampling is based on the assumption that the researcher wants to discover, understand, and gain insight and, therefore, must select a sample from which the most can be learned (Merriam, 1998). This study used the appreciative inquiry model to select two instructive cases with high performing collaboration. Appreciative inquiry is an important component of the strengths-based approach, which focuses on discovering, understanding, and amplifying (Bushe, 1995), helping the researcher to create a more effective design for study (Bushe, 2005). During the discovering phase, the researcher searches for the best examples within the experiences of organizational members. The understanding phase seeks to create insights into the conditions that lead to superior performance—in this case, high performing collaboration. The amplifying phase reinforces people and processes who best exemplify the superior case (Bushe,

1995), which, in this study, is collaboration. Thus, the findings of the quantitative phase helped the selection of two instructive cases of collaboration for the qualitative phase. The qualitative part of the study included interviews with 6th, 7th and 8th grade mathematics teachers in two instructive cases of collaboration with the purpose of giving voice to their experiences and perceptions as teachers.

The participants were contacted through email or phone and were invited to participate in this proposed study. In the beginning of interviews, the participants were informed about the purpose of the study, the methods for maintaining confidentiality, and the right to not participate in this study through a consent form. Appendix D has an image of interview consent form. The participants were also informed about the recording of their interviews. Appendix E has an image of audio recording release form. If the participants agreed to be recorded, they were asked to sign the consent form.

Data collection methods. Using the results of quantitative phase, two teams of 6th, 7th and 8th grade mathematics teacher with the highest performing collaboration were selected as two instructive cases to voluntarily participate in a 60-minute focus group and individual interviews. Out of twenty 6th, 7th and 8th grade mathematics teachers who were invited for this part of the study, fifteen teachers participated in the interviews. Additionally, two teams of 6th and 7th/8th grade teachers participated in two focus group interviews. Four administrators in the same two schools were also interviewed to share their perception on supporting and constraining conditions of effective collaboration. All interviews were conducted in a private room at each school site. The purpose of the interviews was to gain a deeper perspective regarding the structural and cultural conditions that support or constrain teacher collaboration at each site.

The interviews served to ascertain teachers' interpretations of structural and cultural conditions of effective collaboration and their perception of the influence of collaboration on teaching. I used seven interview questions using appreciative inquiry approach for teachers (see Appendix B) and five interview questions for the administrators (see Appendix C). The interview protocol's design reflected the appreciative inquiry model in order to elicit affirmative information from the teachers and administrators about their collaboration experience and its impact on teaching (Cooperrider & Barrett, 2001). Bosch (1998) stated that qualitative factors about an organization—such as being "the best," unique organization characteristics, shared commitment, people, and collaboration—can be elicited with an appreciative inquiry protocol.

The interview protocol for both teachers and administrators included open-ended questions to allow for important participant response information related to the research questions. A collection of multiple participant perspectives created a database of evidence and allowed for an investigation of how the data were interrelated (Yin, 2003). The ultimate comparison of data gathered from surveys and interviews allowed for verification of sources, coding, and themes. The interview data were transcribed, hand coded for discovery of common themes.

Data analysis. The strategies used to analyze interviews will be described in this section. With qualitative data analysis, the researcher needs to prepare the data for analysis, analyze data for deeper understanding, decide how to represent data, and interpret data to create a larger meaning (Creswell, 2003, p. 190). Miles and Huberman (1994) state that the process of data analysis should be done in three phases of data

reduction, data displays during the collection, and conclusion drawing to explain the finding.

The participants signed the consent form providing me with the permission to record and transcribe the interviews.   Numerical codes were used to code the interviews and keep participants' identities confidential. Interviews were transcribed, read, reread, sorted, and coded to identify potential themes that emerged from the data. Interview responses were coded based on extant literature regarding structural factors using the work of Birman and colleagues (2002). Additional frameworks involved the work of Goddard and colleagues (2004) in relation to teacher efficacy and the work of Daly (2009) and Hoy and Tschannen-Moran (1999) for the investigation of trust. Inductive coding was used as guide to categorize and code the responses. During analysis I remained open to emergent codes that may arise unexpectedly from the data and incorporated these into the coding procedure. I manually sorted the interview codes and identified emergent themes, which were analyzed in relationship to the literature found in Chapter 2.

I referred to First Cycle and Second Cycle coding to separate, reduce, group, and regroup the responses (Saldaña, 2009). This process helped me to identify and describe patterns and establish emergent themes. Finally, the results from the analysis of the quantitative data from the first phase were integrated with the themes.

Integration of data. In order to strengthen internal validity, data checking was used between the quantitative and qualitative resources. I linked the findings from the quantitative and qualitative analyses and examined the findings in relation to existing

literature using the lens established in the theoretical framework in Chapter 2. The goal

was to provide answers to the three research questions.

Table 4. Summary of Qualitative Study

Research Question/Participants	Data to Be Collected	Analyses
1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting? 2. What is the interaction between collaboration, structural and cultural conditions in high performing cases? 3. What are teachers' perceptions of collaboration and its influence on their teaching? Participants: 15 math teachers from 6th and 7th/8th grade and four administrators.	Taped interviews with 15 math teachers, and four administrators (seven-question Appreciative Interview Protocol for teachers and five-question Appreciative Interview Protocol for administrators).	1. Interview transcription, coding, and theme identification. 2. Triangulation with themes from literature reviews. 3. Triangulation with quantitative data.

Table 5. Research Process Summary

Research Question	Data Source	Data Analysis
1. What are the structural and cultural conditions of collaboration that support or constrain mathematics teachers' collaboration in a middle-school setting?	1. Survey Data 2. Interview Transcripts	1. SPSS_ Descriptive Statistics, Factor Analysis, Pearson Correlations, ANOVAs 2. Transcribe, Code, Theme, Interpret
2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?	1. Survey Data 2. Interview Transcripts	1. SPSS_ Descriptive Statistics, Factor Analysis, Pearson Correlations 2. Transcribe, Code, Theme, Interpret
3. What are teachers' perceptions of collaboration and its influence on their teaching?	1. Survey Data 2. Interview Transcripts	. SPSS_ Descriptive Statistics, Factor Analysis, Pearson Correlations 2. Transcribe, Code, Theme, Interpret

Positionality

I am currently a mathematics teacher and the participants may have feared that I many have known other math teachers in the district. This fear may have caused them to worry about breach of privacy or data confidentiality. In order to mitigate any discomfort, participants were reassured their responses were going to be kept confidential and nobody other than me had access to the data. Additionally, pseudonyms for the district and each participating school as well as participants were used to minimize risk of potential loss of confidentiality. Furthermore, the participants were informed of the extreme steps that were taken to ensure complete confidentiality by creating a coding system for respondents and restricting access to the data collected.

Chapter Four: Data Analysis

As shown in the review of literature, collaboration is suggested to be an effective strategy to improve teaching and ultimately increasing student achievement in mathematics (Drago-Severson & Pinto, 2006; Lieberman, 2009; Margolis, 2008; Zwart, Wubbles, Bergen, & Bolhuis, 2009). The purpose of this study was to explore the structural and cultural conditions of effective middle-school mathematics teachers' collaboration and investigate the impact of both structural and cultural conditions and their relationship in highly effective cases. This study aimed at capturing teachers' perceptions of collaboration and its influence on their teaching.

Both quantitative and qualitative phases were used as data sources to fully address the research questions. The quantitative phase was used not only to address the three research questions but more importantly to select two cases of high performing collaboration for the qualitative phase. The two cases of high performing collaboration will be referred as instructive cases of collaboration and they will be used interchangeably in this chapter. The qualitative phase was used to provide a better understanding about collaboration and address the research questions from a deeper perspective. The purpose of conducting the mixed-methods study was to investigate not only the structural and cultural conditions as defined by the frameworks used in the study but to also understand how these two sets of conditions may interact.

Research Questions:

    1.   What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?

2.   What is the interaction between collaboration, structural and cultural

conditions in highly effective cases?

3.   What are teachers' perceptions of collaboration and its influence on their

teaching?

The data analysis from surveys resulted in the selection of two high performing

cases of collaboration for the interview phase. I was interested in selecting two high

performing schools because I thought they could provide a better understanding about the

supportive conditions and possible interactions. This chapter will first explain the

quantitative phase followed by the qualitative phase.

Quantitative Data Results and Analysis

To address the research questions and select two instructive cases of

collaboration, a survey comprised of 47 questions was given to middle school math

teachers in two districts. The survey included demographic, structural condition

questions, cultural condition questions and teachers' perception on collaboration. I

administrated the surveys during math meetings to increase response rates. To seek more

depth in survey responses and select two instructive cases of collaboration, once the

surveys were collected and initially analyzed, two schools out of four participating

schools were selected to allow me to conduct 10 one-on one interviews with 6th and

7th/8th grade teachers, two focus group interviews with 6th and 7th/8th grade teachers and

four one-on-one administrator interviews. The rest of this chapter will describe how I

selected the two instructive cases for the interview phase.

A survey instrument, which included questions on the structural conditions, cultural conditions and teaching practice was used to identify the conditions of strong collaboration and teachers' perception while measuring these conditions to select two high performing cases for the interview phase.   The results and analysis of this study's survey responses are presented and discussed in the following sections.

Analysis of the Quantitative Data. To analyze the quantitative data, answer the research questions, and select two instructive cases of collaboration for the interview phase, a variety of statistical analyses were conducted including: descriptive statistics, factor analysis, bivariate correlation tests, and ANOVAS.   Although surveys addressed the research questions to some degree, further study was done using the interviews to provide a better understanding about the research questions.

It is important to note that the survey's data were parametric data because they were measured using a 6-point response scale. Therefore parametric analysis was conducted on parametric data showing normal distributions. All of the statistical procedures were conducted using the statistical package SPSS 17.0 for Mac. The range of these statistical tests allowed me to analyze the data in depth. Table 6 shows the data analysis used to address the research questions and selection of two high performing cases for the interview phase.

Table 6. Research Methodology for Quantitative Research Questions

Purpose	Data Analysis
Address research question 1 1. What are the structural and cultural conditions of reform PD that support or constrain mathematics teachers' collaboration in a middle-school setting?	Descriptive Statistics, factor analysis
Address research question 2 2. What is the interaction between collaboration, structural and cultural conditions in highly effective cases?	Pearson Correlations
Address research question 3 3. What are teachers' perceptions of collaboration and its influence on their teaching?	Descriptive Statistics, factor analysis
Select two instructive cases of collaboration	ANOVA

Participants. The quantitative phase of the study included invitations to all 6th, 7th, and 8th grade mathematics teachers and administrators from one middle school in district A, and three middle schools in district B. Both districts are moderate sized located in Southern California. I purposefully selected these two districts because they both serve high populations of traditionally marginalized students. Both districts serve around 45% Latino, 3% Black, and more than 35% socioeconomically disadvantaged students. All three middle schools in district A participated. Only one school in district B was invited to participate based on the suggestion made by the superintendent of this district.

Description of participating schools. Schools of each district, the number of students and the make-up of student population in terms of socio-economic and ethnic

background at each school are illustrated in Table 7. As this Table shows, Schools 1, 2 and 3 are from district A and school 4 is from district B. The number of students in these four middle schools ranged from 1192 to 1427. School 1 had the smallest percentage of students who were eligible for free or reduced lunch and the highest percentage of white student population.   As the percentages in the Table 7 indicate, schools 3 and 4 had a more similar student population.

Table 7. Demographics Profile of Participating Schools

	Total Students	% Eligible for Free or reduced Lunch	Hispanic	Black	White
School 1 (A)	1427	19%	21%	4%	62%
School 2 (A)	1192	74%	77%	3%	14%
School 3 (A)	1413	45%	51%	3%	39%
School 4 (B)	1277	54%	55%	4%	31%

Description of survey participants. Table 8 represents the participating schools, the number of participants including teachers and administrators, the number of survey responses returned, and each site's usable response rate percentages.   As Table 8 indicates, the overall average return rate of 92% among participants at all the middle schools was consistent with the return rate at each middle school. Two schools had a usable return rate in the 90% range and one of the middle schools returned 100% of the surveys.

Table 8. Average Survey Response Rate

Schools	Number of Teachers and Administrators	Number of surveys returned	Percentage Returned/Used
1	12	12	100%
2	11	10	91%
3	13	12	92%
4	15	13	87%
Total	51	47	92% (Average)

The participating teachers were asked to report on several variables including number of years at their site, years of experience teaching, and whether they had obtained an advanced degree (Masters/Doctorate). As Table 9 indicates, the analysis revealed no significant differences between the groups for years of teaching or years at their school on any of the measured variables. For the average years of teaching by the district, Schools 1, 2 and 3 indicated the highest averages, however with respect to years at their respective school sites, school 4-- the school with the lowest overall years teaching experience-- was on par with the other participating schools. Examining the number of teachers obtaining advanced degrees, teachers at school 4 had the highest number of participating teachers who had obtained advanced degrees.

Table 9. Participant Data Regarding Teaching Experience and Education.

School	Years Teach Mean (Std Dev)	Years Site Mean (Std Dev)	Advanced Degree (N—Y)
1	15.3 (2.9)	5.8 (2.8)	7—2
2	15.7 (2.7)	9.0 (6.6)	5—4
3	13.4 (2.7)	11.1 (3.8)	6—3
4	11.6 (2.6)	10.8 (5.0)	5—5

Survey Factor Analysis. Although items under each construct of the survey have previously been tested for validity for use within educational settings, a Confirmatory Factor Analysis (CFA) was performed as recommended by Antonakis et al. (2003) to ensure all the items of each individual structural and cultural construct loaded on the identified construct. A scree test and an eigenvalue of 1.0 were used to determine the number of components. Items with factor loadings of 0.4 or higher on a single component were used to define the construct. In addition, reliability was tested by the Cronbach's alpha measure (α). Cronbach's alpha is a coefficient of internal consistency of the items of the scale. The field of social science suggests a reliability coefficient of 0.7 and above to be considered "acceptable" (Szklo & Nieto, 2000; Klein, 1999). It is important to note that such general guidelines need to be used with caution because reliability coefficient depends on the number of items on the scale. Tables 10, 11, and 12 illustrate factor loadings and alpha reliability for items of each construct.

As Table 10 indicates, all items of the Teaching Practice (TP) construct emerged on one component with loadings between 0.77 and 0.89 and with Alpha Reliability of 0.95 showing internal consistency of the items of TP.

Table 10. Confirmatory Factor Analysis for Teaching Practice (TP)

Survey Item	Factor Loading (α = .95)
Teaching Practice (TP)	
I apply skills I learn during collaboration	0.767
Collaboration helps me to use differentiated instruction	0.834
As a result of collaboration, I use different forms of Assessment	0.832
My teaching has improved as a result of collaboration	0.858
I have made changes to my teaching as a result of Collaboration	0.875
Our collaboration has helped me to become more effective	0.870
I am committed to some new strategies as a result of Collaboration	0.888
I learn practical teaching strategies during our collaboration	0.831
Our collaboration has a positive impact on student achievement	0.839
I can note changes in my teaching because of our Collaboration	0.807

The confirmatory analysis showed one component for all items of each structural condition as well. Tables 11-14 illustrate the loadings and acceptable Alpha Reliability for each item of individual structural scale (coherence, content, duration, active learning). As Tables 11-14 indicate, all six items of coherence emerged on one component with loadings between 0.467-0.885 and Alpha Reliability was 0.88. Two items of content reflected one component with loading of 0.886 and Alpha of 0.72 reflecting the lowest Alpha Reliability in comparison to the other constructs. The lowest Alpha Reliability could be due to the fact that this construct had only two items, making it somewhat a

weak construct. Therefore, it is important to be cautious about relying on this construct. Six items of duration had loadings that ranged from 0.642 to 0.847 reflecting one component and Alpha Reliability was 0.84. Three items of active learning had loadings between 0.827 and 0.863 showing in one component and Alpha Reliability was 0.78.

Table 11. Confirmatory Factor Analysis for Structural Scales-Coherence

Survey Item	Factor Loading (α = .88)
Coherence	
Our collaboration has planned activities with specific topics	0.885
Our activities are connected and followed up by the previous activities	0.875
Our activities are consistent with teachers' classroom goals	0.883
Our activities support national, state, district standards	0.853
Our activities are ongoing activities throughout the year	0.752
Math teachers collaborate outside their contract hours	0.467

Table 12. Confirmatory Factor Analysis for Structural Scales—Content

Survey Item	Factor Loading (α = .72)
Content	
Our focus is on the deepening teachers' knowledge of math	0.886
The content of our collaboration has relevance to teachers' needs	0.886

Table 13. Confirmatory Factor Analysis for Structural Scales—Duration

Survey Item	Factor Loading ($\alpha = .84$)
Duration	
Our master schedule provides at least 1 hour to collaborate	0.817
Our principal provides additional collaboration time if needed	0.847
Our school provides teachers with extra time to visit Classroom	0.799
We are provided with time to collaborate by common planning time	0.706
We have collaboration time by extra days built into yearly Schedule	0.660
Our collaboration allows teachers regular observations by peers	0.642

Table 14. Confirmatory Factor Analysis for Structural Scales—Active Learning

Survey Item	Factor Loading ($\alpha = .78$)
Active Learning	
During our collaboration teachers share instructional practices	0.863
During our collaboration, teachers share student work	0.831
During our collaboration teachers develop lesson plans	0.827

The confirmatory analysis showed one component for all items of each cultural

scale. Tables 15 and 16 illustrate the loadings and acceptable Alpha Reliability for each

item of cultural scale. As these tables indicate, all five questions of trust loaded between 0.753 and 0.928 with one component and Alpha Reliability of 0.88. Items 1-4 of collective efficacy for teaching (CE1) loaded between 0.715 and 0.856 showing one component with Alpha Reliability of 0.79. Items 1-3 of collective efficacy overall (CE2) loaded between 0.682 and 0.750 showing one component and Alpha Reliability of 054. Items 1-3 of individual efficacy for students (IE1) loaded between 0.809 and 0.837 showing one component and Alpha Reliability of 0.75. The individual efficacy for teaching (IE2) items 1-3 loaded between 0.602 and 0.838 showing one component and Alpha Reliability of 0.62.

Table 15. Confirmatory Factor Analyses for Trust and Collective Efficacy

Survey Item	Factor Loading (α = .88)
Trust	
Teachers trust each other	0 .839
Teachers can rely on each other	0 .928
Teachers have faith in the integrity of peers	0.895
Teachers feel safe to open their classrooms	0.762
Teachers share information	0.733

Survey Item	Factor Loading (α = .79)
Collective Efficacy for Teaching (CE1)	
Teachers believe their peers are competent	0.793
Teachers can get through difficult students	0.715
Teachers are skilled in various methods	0.856
Teachers are well prepared to teach math	0.803

Survey Item	Factor Loading (α = .54)
Collective Efficacy Overall (CE2)	
Teachers can motivate students	0.682
Teachers can get students to learn	0.750
Teachers believe every student can learn	0.740

Table 16. Confirmatory Factor Analyses for Individual Efficacy

Survey Item	Factor Loading ($\alpha = .75$)
Individual Efficacy for Students (IE1)	
I can get through to difficult students	0.809
Different method to teach struggling students	0.812
Increase students' retention for next lesson	0.837

In sum, the result of Confirmatory Factor Analysis (CFA) indicated that each construct was statistically independent in measuring distinct scales, as measured by the 47 survey items, and further confirmed the construct validity of strong collaboration. In addition, the Alpha Reliabilities shown in the tables revealed that there was internal consistency in items of each survey construct.

The validity and reliability of the instrument laid a solid foundation upon which I was able to use the instrument to inform the research questions. The following section presents quantitative findings that answer research questions one, two and three using the survey constructs and descriptive and inferential analyses to understand the relationships between strong collaboration and structural and cultural conditions under study.

Descriptive Statistics of Constructs. In this study, since I was interested in identifying the best performing schools, I ran descriptive statistics to identify the mean, minimum, maximum and standard deviation for each structural and cultural construct by school and by grade level. Tables 16 and 17 show the information for both 6th and 7th/8th grade for four schools.

As Table 17 shows, school 4 for the 6th grade team has the highest mean scores for all structural factors except for duration. In respect to the cultural conditions as Table 18 indicates, school 4 had the second highest mean score for trust, CE1 for teaching, the third highest mean score for CE2 overall, the second highest mean score for IE1 for students and the highest mean score for IE2 for teachers. As shown in Tables 17 and 18, the 7th/8th grade team at school 4 had the highest mean scores of 5.38 for TP, 5.67 for coherence, 5.13 for content, 4.29 for duration, 4.75 for active learning, 5.62 for CE1, 5.42 for CE2. Additionally, the comparison between the mean scores of all schools for all constructs suggests that the 7th/8th grade team at school 1 overall had the second highest mean scores. Therefore these two schools were looked at more closely for further analyses.

Table 17. Descriptive Statistics of Structural Conditions

Conditions	School 1	School 2	School 3	School 4
Structural Conditions				
Teaching Practice 6 Mean	4.11 (0.53)	4.11(1.12)	4.33(0.32)	5.42(0.52)
Teaching Practic7/8 Mean	5.03 (0.85)	3.68 (0.65)	4.4 (0.62)	5.38 (0.54)
Coherence 6 Mean	3.9 (0.87)	3.79 (0.76)	4.28(0.51)	5.41 (0.64)
Coherence 7/8 Mean	5.17 (0.76)	3.5 (0.91)	3.64 (1.08)	5.67 (0.33)
Content 6 Mean	3.92 (0.97)	3.38 (0.63)	4.17 (0.76)	4.92 (1.07)
Content 7/8 Mean	4.83 (1.26)	3.1 (0.96)	3.5 (1.0)	5.13 (0.48)
Duration 6 Mean	2.14 (1.12)	3.79 (1.14)	2.78 (1.77)	2.72(1.13)
Duration 7/8 Mean	2.56 (1.01)	2.53 (0.63)	2.36 (0.67)	4.29 (0.71)
Active Learning 6 Mean	2.94 (1.04)	3.00 (0.94)	3.89 (0.962)	4.5 (0.691)
Active Learning 7/8 Mean	3.78 (1.64)	3.07 (0.79)	3.39 (0.93)	4.75 (0.17)

Table 18. Descriptive Depictions of Cultural Conditions

Conditions	School 1	School 2	School 3	School 4
Cultural Conditions				
Trust 6 Mean	5.23 (0.81)	4.8 (0.16)	5.93 (0.38)	5.67 (0.48)
Trust 7/8 Mean	5.67 (0.58)	4.44 (0.33)	5.8 (0.4)	5.75 (0.5)
CE1 6 Mean	5.13 (0.65)	4.69 (0.24)	5.58 (0.38)	5.46 (0.46)
CE1 7/8 Mean	5.0 (0.43)	4.65 (0.76)	5.38 (0.47)	5.63 (0.43)
CE2 6 Mean	5.0 (0.59)	5.25 (0.42)	5.22 (0.51)	5.19 (0.65)
CE2 7/8 Mean	5.11 (0.51)	4.67 (0.62)	5.06 (0.57)	5.42 (0.42)
IE1 6 Mean	4.50 (0.69)	5.08 (1.07)	4.66 (0.58)	4.72 (0.77)
IE1 7/8 Mean	4.77 (0.38)	4.33 (0.72)	5.00 (0.28)	4.33 (0.5)
IE2 6 Mean	4.72 (0.88)	4.50 (1.17)	4.66 (0.58)	5.08 (0.57)
IE2 7/8 Mean	5.0 (0.33)	4.66 (1.06)	4.88 (0.75)	4.5 (0.43)

Note. n =47 participants., *Note*. Mean (SD)

In sum, to identify two instructive cases of collaboration for the interview phase of the study, descriptive statistics for each structural and cultural construct by school and by grade level was conducted. The comparison of mean scores of structural and cultural constructs for all schools by 6th and 7th/8th grade revealed that schools 1 and four overall had the highest mean scores for most constructs. These mean scores describe the Likert-scale ratings from the survey on a 6 point scale. Therefore these two schools were selected for further analyses.

There will be a graphic representation of Tables 17 and 18 in the ANOVA analyses section. The following section describes the correlation table of all computed variables to look for relationships between and among variables and respond to the second research question in the study.

Correlations of Computed Variables. The high correlations between the items of structural conditions in Table 19 support the literature review in that structural conditions in effective collaboration are positively correlated (Birman et al., 2002). As Table 19 indicates, all the structural factors of coherence, content, duration and active learning had strong positive correlations. For example content reflected strong positive correlation with coherence (.785[**]) indicating that these two constructs occur together frequently. Active learning showed strong positive correlation with coherence (.747[**]) suggesting that when teachers collaborate consistently on their own time they increase their learning. Active learning also revealed strong positive correlation with content (.745[**]) suggesting that the more teachers focus on the content the more they learn and ultimately improve their teaching practice.

Teaching Practice (TP) showed positive correlation with all four structural conditions of coherence, content, duration and active learning suggesting that structural conditions positively impact teaching practice. Especially, TP had the strongest positive correlation with content (.803 [**]) indicating that the more teachers discuss content, the higher their perception of their teaching is. Similarly TP had the second strongest positive correlation with coherence (.791 [**]) indicating that the more teachers spend their own time to collaborate, the higher their perception of their teaching. The literature review also showed that these structural factors have a positive relationship with teaching practice (Birman et al., 2002).

Table 19 additionally reveals that the items of cultural conditions were positively correlated. For example trust was highly correlated with both collective efficacy overall (.415 [**]) and collective efficacy for teaching (.714 [**]). This finding supports the literature in that trust and collective efficacy are positively correlated (Chester & Beaudin, 1996; Esselman & Moore, 1992; Hoy & Woolfolk, 1993; Rosenholtz, 1989). The greater the degree of perceived trust, the stronger the belief in teachers' ability to engage and implement a course of actions leading to success (Tschannen-Moran's ,1999). Table 19 also reveals that individual efficacy for students is positively correlated with collective efficacy overall (.403 [**]). This finding supports the literature review in that individual efficacy is influenced by a school's culture of collective efficacy (Goddard & Hoy, 2004).

Perhaps most importantly, Table 19 illustrates that there are positive correlations between structural and cultural items, addressing the second research question. For example, coherence is positively correlated with collective efficacy overall (.374 [**]) and

with trust (.256). Active learning is positively correlated with trust ((.243). Content is

positively correlated with individual efficacy for students (.158 [**]). Coherence is

positively correlated with collective efficacy for teaching (370 [*]) and active learning is

positively correlated with collective efficacy for teaching (.233). As the literature review

indicated, the structural and cultural conditions were more independent than completely

dependent, however the analysis of this correlation table showed that structural and

cultural conditions were positively correlated due to the fact that there were many

correlations found between structural and cultural constructs.

In sum, correlation analysis as shown in Table 19 provided evidence in explaining

the interactions between structural, cultural and Teaching Practice (TP) constructs. The

results of correlation analysis indicated that structural constructs such as coherence,

content, duration and active learning were positively and significantly correlated with

Teaching Practice, suggesting that teachers who gave high rankings to the structural

conditions tended to have greater perception for improving their teaching practice. The

cultural conditions of trust, CE1, CE2, IE1 and IE2 were positively correlated with TP as

well indicating that cultural factors positively influence teaching practice.

All the structural conditions were positively correlated with cultural conditions.

This positive correlation suggests that teachers who had high perception of trust,

collective efficacy and individual efficacy tended to have high perception of coherence,

content, duration and active learning with one exceptions. There was a negative

correlation between trust and duration suggesting that those with high level of trust were

less likely dependent on structured time provided by school to collaborate. As it became

evident in interview responses, with high level of trust teachers collaborated on their own

time and did not depend on time provided by school. These correlations indicated that an

effective collaboration that could improve teaching practice in this sample was associated

with structural and cultural conditions combined together as proposed model in this

study.

Table 19. Correlation Matrix for Variables Used in the Analysis

	1	2	3	4	5	6	7	8	9	10
Structural Conditions										
1. Coherence	--									
2. Content	.785**	--								
3. Duration	.344**	.392**	--							
4. Active Learning	.747**	.745**	.437**	--						
Cultural Conditions										
5. Trust	.256	.133	-.117	.243	--					
6. CE1 (Teach)	.370*	.211	.065	.233	.714**	--				
7. CE2 (Overall)	.374**	.127	.217	.163	.415**	.671**	--			
8. IE1 (Student)	.076	-.158	.047	-.001	.118	.291*	.403**	--		
9. IE2 (Teacher)	.285	.193	.065	.179	.089	.187	.326	.233	--	
Teaching Practice										
10. Teaching Practice	.791**	.803**	.409**	.725**	.191	.214	.244	.012	.135	--

Note. n = 47 $^*p < .05.$ $^{**}p < .01.$

The following section explains the ANOVA analyses that were run to select two

instructive cases for the qualitative phase. As it was noted earlier, Tables 17 and 18

shown in the Descriptive Statistics section will be graphically represented in the next

section to make the differences between four schools visual and easier to understand.

ANOVA Analyses. Since the data were parametric data, the assumed distribution

was normal**.** The use of ANOVA analyses is justified because the required assumptions

of normal distribution of data, independence of cases, and equality of variance (each

group's variance is equal) are met. Another reason to justify the use of ANOVA tests is because this study involved five structural and five cultural variables in four schools per grade level. Therefore ANOVA analysis was employed to infer if there were differences between the four schools. The results were used to narrow down our focus to two schools and select the two high performing cases for the interview phase. Responses were scaled and measured using a 6-point response scale. The individual ANOVAs were run to find the average scores for each of the Teaching Practice (TP), structural and cultural constructs, as defined by the statistical model, to examine the differences across the four school sites and aid the case selection. A 4X2 between-factor ANOVA (four schools and two grade teams) was applied to each confirmed construct. The evaluation of grade level on each of the construct measures was conducted by grouping 7th and 8th grade teachers. This was done since the majority of the 7 and 8th grade teachers taught both 7th and 8th grade math, hence the comparison for grade was between two rather than 3 groups. The resulting 4X2 ANOVA used the between factors SCHOOL (1,2,3,4) and GRADE (6, 7/8). The patterns of performance on the various scales were used to differentiate both school and grade level team.

When looking at scores on the selected scales by grade, overall, the results were consistent with the evaluation of means by school as seen in Tables 17 and 18. There was a significant difference for school site on the scales of Teaching Practice (TP), $F_{(3,29)}=8.38$, $p<0.001$; Coherence, $F_{(3,29)}=9.88$, $p<0.001$; Content, $F_{(3,29)}=6.06$, $p<0.005$, Active Learning, $F_{(3,29)}=5.00$, $p<0.01$; Trust, $F_{(3,29)}=10.78$, $p<0.001$; and Collective Efficacy-Component1, $F_{(3,29)}=5.34$, $p<0.01$. There was no main effect of Grade for IE1 or IE2 or CE2. For Duration there was a significant interaction for School X Grade,

$F_{(3,29)}=3.2$, $p<0.05$. No other constructs showed significant main effects of Grade, or the higher School X Grade interaction. (See Figures 2 and 3)

In Figure 3, all teachers in four schools reported perceptions of their own teaching practice (TP). As this figure indicates, there was a significant effect of School, but no significant School X Grade effect. (Error bars = SEM). Although there was no significant interaction between TP and Grade, it is clear that the explanation for the high ranking of School 1 for TP was caused by the high ratings by the $7^{th}/8^{th}$ grade team. Thus, according to Figure 3,

School 4 had the highest mean scores of TP for both 6th and $7^{th}/8^{th}$ grade teams, and School 1 had the second highest mean scores for TP.
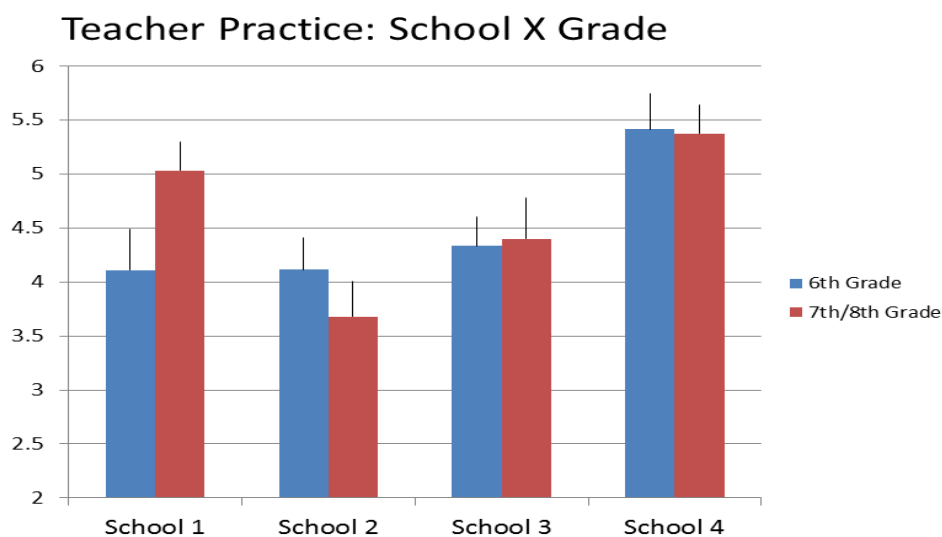
Figure 3. Teacher Practice: School X Grade

Figure 4 represents the mean scores of cultural and structural factors for each school and grade. As Figure 4 indicates, overall the cultural factors are higher than structural factors, pointing to the important role of cultural conditions (also later evident

in the interview responses). As was apparent by the mean scores of constructs, School 4 was the highest in structural and cultural factors, however this effect was most pronounced for the structural factors, which tended to produce lower scores in general across each of the teams. In particular, the structural factor duration was associated with the lowest scores. Duration was also the only survey construct showing a significant interaction between School X Grade. This interaction can be seen in the relatively high values given for duration by select grade level teams (i.e. School 4, grade 7/8; School 2, grade 6). Based on these results, teams at School 1 and School 4 were selected as two instructive cases for the interview phase of the study. It is important to note that we looked at the Standardized Testing and Reporting (STAR) results in both schools and the reports indicated a consistent growth in the mathematics performance of students.

In sum, Figure 3 indicated that School 4 had the highest mean scores of Teaching Practice (TP) for both 6th and 7th/8th grade teams and school 1 had the second highest mean scores of TP for both teams. As was apparent by the mean scores of structural and cultural constructs shown in Figure 4, overall school 4 had the highest mean scores for both structural and cultural constructs, and school 1 overall had the second highest mean scores for structural and cultural constructs.
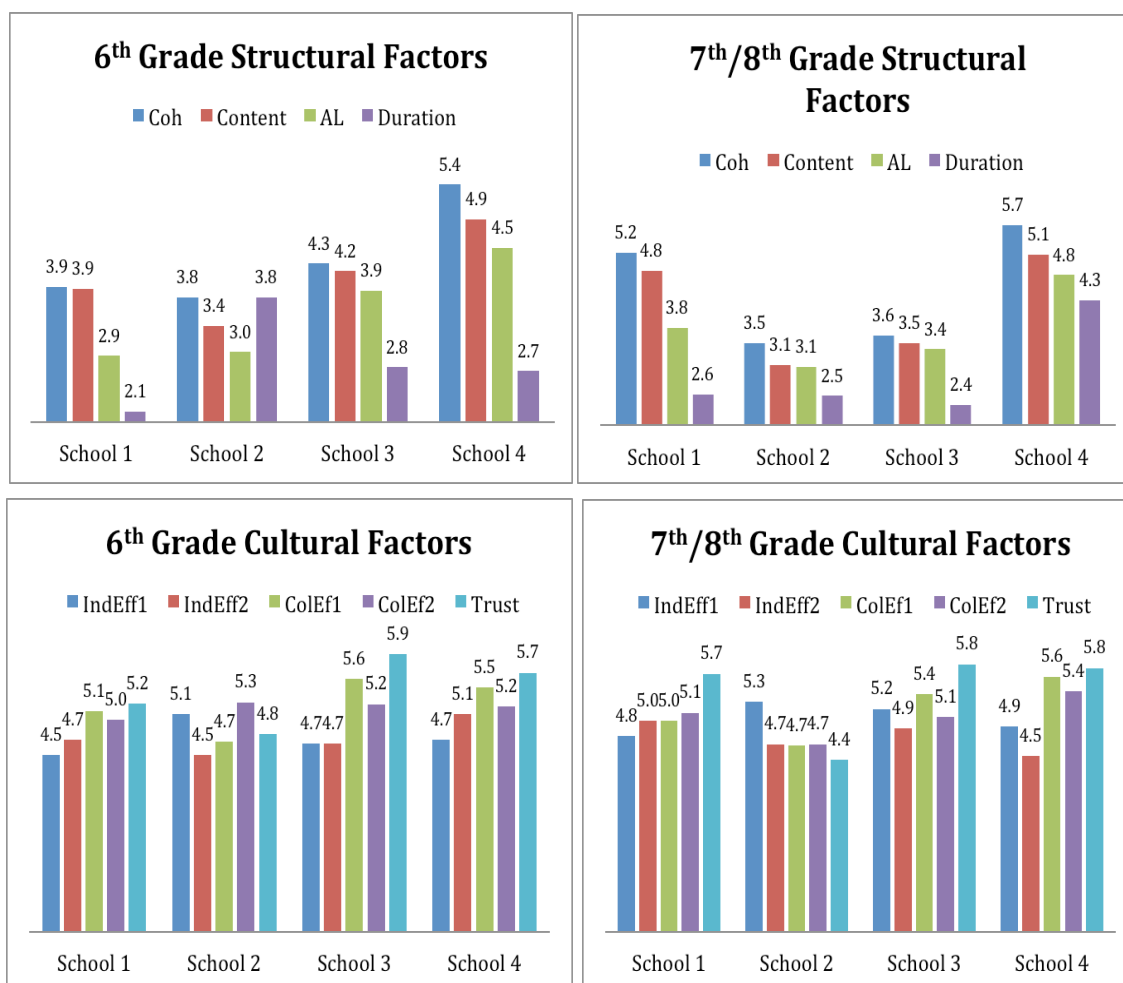
Figure 4. Structural and Cultural Constructs: School X Grade

Summary of Quantitative Phase. As it was stated earlier, the survey data were parametric data because they were measured using a 6-point response scale. Therefore parametric analysis was conducted on parametric data, and the distribution was normal.

Table 20 illustrates that the quantitative portion of this study of conditions of high performing collaboration in middle school produced several findings. It addresses the first research question and helps identify the structural and cultural conditions that occur in high performing cases of collaboration. Second, to some degree, it addresses the

second research question, revealing positive correlations between structural and cultural conditions. It also addressed the third research question by showing the positive correlations between teachers' perception of their teaching practice (TP), and structural and cultural conditions. The interviews will address the three research questions more extensively.

Lastly, the mean scores of structural, cultural and teaching practice constructs were used to select two high performing schools for the interview phase. The results of ANOVAs indicated that School 1 and School 4 had the highest overall average scores for all constructs. Therefore, School 1 and School 4 were selected as two instructive cases of collaboration for the qualitative phase of the study. Generally, schools with strong collaboration tend to demonstrate a high degree of coherence, content, active learning and duration (structural conditions) as well as high degree of trust and collective efficacy and individual efficacy (cultural conditions) as supportive conditions of collaboration. Both schools showed high mean scores for teaching practice, suggesting that teachers who had high perception of structural and cultural conditions tend to have high perception of teaching practice. Thus, the high degree of teaching practice had a positive relation with both structural and cultural conditions in these two schools. The constraints of strong collaboration emerged during the second phase of the study.

Table 20. Results of Quantitative Study

Purpose	Findings
Research Question 1: What are the structural and cultural conditions of reform PD that support or constrain mathematics teachers' collaboration in a middle-school setting?	Factor analysis and Descriptive Statistics identified coherence, content, duration and active learning as supportive structural conditions and trust, collective efficacy and individual efficacy as supportive cultural conditions.
Research Question 2: What is the interaction between collaboration, structural and cultural conditions in highly effective cases?	Pearson correlation table pointed to the positive correlations between all structural and cultural, constructs
Research Question 3: What are teachers' perceptions of collaboration and its influence on their teaching? Selection of Two Instructive Cases of Collaboration	Pearson correlation table showed that teachers' perception of their teaching practice (TP) is positively correlated with both structural and cultural conditions. The use of ANOVA test is justified here because the required assumptions of normal distribution of data, independence of cases, and equality of variance (each group's variance is equal) are met. The individual ANOVAs pointed to the differences between 4 schools by comparing the means. It helped to compare the average scores of teaching practice, structural and cultural constructs for 6th and 7th/8th grades at four schools. Overall the average scores of teaching practice, structural and cultural constructs for school 4 and school 1 were the highest. Therefore these two schools were selected for the interview phase.

The next section, the qualitative phase, will further address the research questions and provide a better understanding about the structural and cultural conditions while it investigated the interactions between all these constructs.

Qualitative Data Results and Analysis

In analyzing the quantitative part of the study, it was found that the structural and cultural factors were both important contributing conditions of collaboration. Perhaps more importantly, these conditions were strongly and positively correlated. The quantitative data also supported the identification of two instructive cases of collaboration from which subjects were drawn to participate in the qualitative analysis. Although there were some variations in these two cases, they were both treated as one case of high performing collaboration, reflecting similar conditions for the following reasons: 1. Both cases reflected middle school settings and same grade levels. 2. Both cases scored high on the average of most structural and cultural constructs and teaching practice. 3. The quantitative data showed that teacher responses in these two schools were similar. After the individual interviews with teachers at the two selected schools, the comparison of interview responses across all themes indicated that teachers in these two schools with the same grade level perceived collaboration the same way qualitatively. Thus, despite demographic differences in the student population, since teacher responses were similar both quantitatively and qualitatively, these two schools were treated as one case of high performing collaboration.

It is important to note that this study included two separate quantitative and qualitative phases because the quantitative phase primarily was used as a sampling

strategy. In addition, the data in the quantitative phase was analyzed and used to identify general findings about collaboration in the two particular schools while the qualitative phase assisted in gaining a deeper understanding about collaboration in these two particular schools.

In this part of the study, I will explain some of the themes that emerged and were structural in nature although they interrelated with the cultural factors. Then, I will explain some of the themes that emerged and were more cultural in nature yet still interrelated with the structural factors. Next, I will explain the details regarding this interrelationship followed by a chapter summary.

The qualitative phase increased the comprehensive nature of the overall findings, added methodological rigor, and ascertained important themes in high performing collaboration cases. Further, given the quantitative findings that both structural and cultural conditions are present in instructive cases of collaboration, learning more about how these conditions interact and teachers' perception of collaboration allowed for the three research questions to be answered in more depth. The qualitative part of the study included interviews with 6th, 7th and 8th grade mathematics teachers at two instructive cases of collaboration with the purpose of giving voice to their experiences and perceptions as teachers. Out of twenty 6th, 7th and 8th grade mathematics teachers who were invited for this part of the study, fifteen teachers participated in the interviews. Additionally, four administrators in the same two schools were interviewed to share their perception on supporting and constraining conditions of effective collaboration.

Themes Emerging from Qualitative Research. The in-depth analysis of the interview data revealed ten interview response themes that were related to the structural

and cultural constructs and were reflected in the quantitative phase as well. These themes are aligned with the three research questions driving the study. The first six themes are about the structural conditions and the other four themes reveal information about the cultural conditions.

The following sections will discuss each of the structural themes and the four cultural themes and the interaction between the structural and cultural themes. Within each theme, the supporting and constraining conditions of collaboration in response to the first research question will be highlighted. The interaction between the structural and cultural themes will address the second research question. The third research question will be addressed through the discussion of teacher learning through collaboration theme. This chapter will end with a discussion about the interaction between qualitative and quantitative and a summary of this chapter.

Structural Themes. The analysis of interview responses revealed six structural themes: time as an important factor of collaboration, teacher learning through collaboration, focus on teachers' content knowledge, focus on teachers' daily classroom goals, participation of teachers of the same grade level and the importance of physical proximity as contributors to collaboration. Since all these themes except for physical proximity overlapped, and in an effort to have a better understanding of these themes, I will separate each with the acknowledgement that they overlap.

Length of time as an important factor of collaboration. A consistent theme among all interviewees as they answered questions about their experience with collaboration was about the length of time of their collaboration. This dominant theme was suggested as duration, one of the structural factors, in the literature review. The

duration of an effective collaboration extends for a significant length of time, such as the entire school year. The span of time over which the collaboration takes place should be long enough to provide teachers with sufficient time to focus on curriculum, student learning issues, and continuous evaluation of effective teaching strategies (Birman et al., 2002). Teachers in this study discussed the concept of spending their own time throughout the year as a supporting condition to the success of their collaboration. Teachers met during lunch, before or after school to discuss students, shared lessons and strategies. A 6th grade teacher commented, " There is five of us who eat lunch together and to be honest with you that is when the most sharing goes on; that is when most of our collaboration happens." (641).

Throughout the year, teachers held meetings that were long enough to provide them with sufficient time to discuss lessons and strategies they were implementing in their classrooms. A 6th grade teacher who represented the majority of her team's perspectives shared, "When we meet after school, we make sure we spend enough time on everything that we need to." (611). By spending their own time, teachers had the flexibility to have sufficient time to focus on grade level curriculum and student learning issues. The ongoing aspect of their collaboration was echoed in a comment of a 7th grade teacher who represented an overwhelming number of opinions in her team, "A day does not go by that we don't talk about what we are doing in our class. Our share is a continuum throughout the year." (743). The ongoing nature of the interviewees' collaboration throughout the year and the sufficient span of time over which the interviewees discussed their plans reflect the duration, one of the structural conditions of the proposed model in the study. These opinions were shared across both schools.

Constraints of length of time as an important factor of collaboration. Although ongoing meetings during lunch, before, and after school were referenced as essential for the success of their collaboration, these teachers also recognized the difficulty of time as one of the constraints of collaboration. Teachers felt more time built into the master schedule for the purpose of the same curriculum collaboration would reduce some of the time pressure and benefit teachers in two ways. First, it would help teachers— particularly the new ones—to develop and nourish relationships with teachers of the same curriculum. As this relationship became stronger, teachers increased their willingness to find additional time on their own and further informally collaborate. A new teacher who had been at her site only for two years commented:

> I think more time built into our master schedule to talk with other teachers
> about teaching our curriculum would be the most helpful because it would
> help me to develop a better relationship with all the teachers in my team
> and go to them on my own time for more collaboration. (713)

Second, more time would help teachers choose topics that are mostly beneficial to their everyday practice. A 7th grade teacher who thought the topic of their math department meeting was too general commented, " We are missing structured time with the same curriculum teachers and we need it back so we can share ideas and best practices with colleagues teaching the same content." (712). Pertaining to the topics of their department meeting, a 6th grade teacher commented:

> I would like 6th grade team to have some time just to focus on 6th grade
> math issues because there are times that we talk about things that don't
> pertain to 7th and 8th grade teachers. Now our meeting with 6th grade math
> teachers is happening on our own time during lunch or after school. (642)

Another teacher shared the benefit of additional time built into the master schedule as a way to reduce stress while supporting teacher learning:

> If we had extra time built into our schedule to meet and explore other avenues whether to use a different way of teaching or sharing ideas that would reduce some of the pressure...because right now we meet on our own during lunch and after school." (646)

Changes in teachers' knowledge and practice require additional time built into the master schedule to provide teachers with opportunities to share and learn.

Teacher learning through collaboration. Teacher learning was the most dominant theme among all interview responses across both schools. This theme answered the third research question, which concerned teachers' perceptions of collaboration and its influence on their teaching. During effective collaboration, teachers become active learners through sharing lessons, observing other teachers, getting feedback, reflecting, and revising their practice leading to teaching improvement (Birman et al., 2002; Banilower & Shimkus, 2004; Boroko, 2004; Darling-Hammond, 1997). In this study, teachers became active learners by sharing lessons and strategies and visiting classrooms. Teachers shared materials, lessons, and strategies as a way of learning and improving their teaching. A new teacher who felt sharing was a common approach in her team stated, " It's wonderful because we always share lessons and strategies and that's how I feel I am becoming a better teacher." (813)

The learning that resulted from widespread sharing was not limited to new teachers. Teachers who had taught for many years also expressed their interest in sharing lessons and strategies. A veteran teacher who felt it was important to be flexible and consider different approaches shared:

> I think sharing ideas improves your own teaching no matter how many years you have been teaching because we don't have all the answers and everyone sees things from different angles and that is what makes it so

nice. I never thought of that and it works out so much better that way."
(842)

The participants reported that visiting classrooms was another way of learning. Teachers benefited from observing both teaching strategies and classroom management. A new teacher expressed how she improved some of her teaching strategies as a result of visiting, " When I started teaching, I wanted to learn so I was in everybody's room sitting and watching, and I was in A's room a lot just sitting and watching how she taught." (712). Several experienced teachers shared the same view on the impact of classroom visits on their teaching techniques. An 8th grade teacher who thought it was important to continue to sharpen her teaching skills commented, " It's really nice to see other teachers. So I try to mimic, just like she tries to mimic, and you just kind of play off each other." (842)

The positive attitude about teaching improvement was reflected in the voices of teachers ranging from all years of experience, " That's valuable at anytime in your career, whether it's the beginning your 3rd year, your 5th year or 30th year! You always need to be refreshed." (643). Similarly another experienced teacher noted:

> It's always nice to have someone in your class and get feedback because sometimes we feel we are doing the best we can, then someone can come in and tweak one little thing and help you become more effective with students. (642)

The interview responses indicated that as a result of observation, teachers of all years of experience showed an increased tendency to change the ways they taught mathematics and adapt to alternative pedagogical strategies.

Visiting other classrooms also helped the interviewees improve their classroom management. A new teacher who felt she needed help with her classroom management commented:

> I observe how she's teaching, both classroom management and teaching techniques. And then I grab something here and there, and it's like, 'Okay, I'm going to use this classroom management and try it and see if it works in my classroom." (7/842)

These responses demonstrated that regardless of the years of experience, teachers in these two successful cases were open to the idea of learning from each other. They shared lessons and strategies and visited classrooms. This cycle of sharing, visiting, implementing new techniques, and modifying strategies helped teachers become active learners and ultimately improve their teaching practice.

Constraints of teacher learning through collaboration. Although visiting each other's room was perceived as an effective way to improve teaching practice, the constraint of time was again voiced by an overwhelming number of teachers. One new teacher who thought observation was a good way of learning shared, " But we don't have a lot of time to do that. If we had time we would do that a lot more and that would be a great learning experience." (712)

Teams with different prep times were able to visit each other's room more frequently. Teachers of one team who continuously observed each other's teaching during prep shared, " We are always in each other's classroom watching the lesson and what the kids are doing; it's wonderful to have a different prep." (7/81). However for the other teams who had common prep time, finding time to visit became more of a challenge. Teachers felt having a common prep time is a constraint to classroom

visitation, " We all have common prep, so we can't go to each other's room during our prep and say, ' Hey I want you to teach that lesson and see how it goes'." (611). Teachers felt with a different prep time, they would have opportunity to visit each other more frequently and improve their teaching practice.

Focus on teachers' content knowledge. In this study, focus on the content— another structural condition— was evident in teachers' responses. While speaking about the topic of their collaboration, a 6th grade teacher commented, " When we get together we talk about lessons and standards that we need to teach." (642). A focus on content arose as a frequent theme. A 6th grade teacher represented an overwhelming opinion of the importance of identifying learning goals for the standards, "Usually we need to know what is the standard and what learning target we are working on." (643)

In particular, teachers who were new to the curriculum discussed the importance of having a daily dialogue about content with their colleagues. A new 7th grade teacher who has been at her site for two years commented, " This year I have been collaborating a lot with the other geometry teacher because this is my first year teaching Geometry. It has been very helpful to talk about the concepts of Geometry and how to teach them." (711). While explaining the benefits of focusing on the shared curriculum, a 6th grade teacher commented, " We talk about lessons that are mostly activity based and how to design those lessons and how to get them crossed." (642). Teachers in these schools focused on the shared curriculum, recognized the important standards, and identified learning objectives during their collaboration. Thus, teachers' responses on content support the literature in that effective collaboration entails improving teachers' content knowledge in their subject matter (Birman et al., 2002; Cohen & Hill, 1998).

Focus on teachers' daily classroom goals. The interview responses across both schools revealed that the activities of teachers' collaboration were connected to each other; they were relevant to teachers' everyday work and they were consistent with teachers' daily goals. A 6th grade teacher excitedly shared, " It's so nice to talk about what we are doing in our class every day and plan lessons for the entire week together." (642). Having a daily dialogue about the lessons that teachers previously taught and the lessons they were going to teach in the future was a common approach among all participants. " It is important to eat lunch together every day so we can talk about how the lesson went and what lesson we need to do the next day." (612). Teachers in this study consistently met and discussed their daily goals, outcomes of the lessons they had planned together, and the effectiveness of teaching strategies they had implemented. This finding supports the literature in that the activities of strong collaboration are coherent, consistent with teachers' goals, build on previous activities, and are followed by additional activities. These connected activities improve teaching practice and knowledge because they relate to teachers' everyday classroom instruction and pedagogy (Birman et al., 2000; Strahan & Hedt, 2009).

Participation of teachers of the same grade level. Collective participation of teachers from the same grade level teaching the same subject impacts the outcomes of collaboration. The collective participation of teachers creates a powerful form of collaborative sharing of knowledge—leading to better teaching (Birman et al., 2002; Banilower & Shimkus, 2004; Borko, 2004; Desimone, 2009; Rosenholtz, 1989). Across both schools, teachers from the same curriculum met before or after school and during lunch to discuss common curricular materials, teaching strategies, and shared goals for

student achievement. A 7th grade teacher who was new to the 7th grade curriculum shed light on the importance of collaborating with her peers who taught the same subject and the same grade level, " For me, this is the first time I have taught in the middle school, so I have relied a lot on what and how my colleagues taught last year. So I have gone to them for help and they have helped me a lot with my teaching." (711). Similarly, another teacher who was new to the 8th grade curriculum commented about the benefit of working with the same grade level teachers:

> That was exactly what I needed. I needed to know what to teach and how
> to teach it, and between the two of my colleagues, all day long, they sat
> down with me and went over the entire book with me." (811)

The collaboration of teachers who taught the same curriculum helped the participants in this study to enhance both their content knowledge and teaching strategies.

The importance of physical proximity. Teachers discussed the concept of physical proximity as advantageous for the frequency of their informal collaboration. Being close to each other, teachers were able to meet before and after school, lunch and passing time. Physical proximity was a supportive condition for these teachers as they related to the tensions between lack of time and the need to meet. A 7th grade teacher shared, " It's because we're so close. You don't even have to think twice. Oh, I have to make time to go see whoever." (712). Similarly a 6th grade teacher commented, "We are right next to each other and people who are literally next door do the most collaboration." (612). Teachers expressed that the fact they are all in the same corridor makes it easier to meet. One 6th grade teacher stressed the importance of, " location and proximity" (643) while she was describing her past experience when she felt isolated due to being far from her peers.

In thinking about physical proximity and its impact on teachers' willingness to meet a new teacher disclosed the following about the benefit of being close to her peers: " We are always communicating because we all work in the same building, so we constantly talk to each other about what we are doing." (711). It was widely shared that physical proximity was a contributing factor to the frequency of their meetings. Although physical proximity was not a component of the proposed model, all teacher responses echoed its critical role on the frequency of their collaboration. This theme was found to be a new supportive structural condition and will be added to the proposed model in this study.

Cultural Themes. While interview responses reflected that structural factors were supportive conditions of teacher collaboration, the responses echoed a high perception of collective efficacy and trusting relationships that enhanced teacher collaboration in these two instructive cases. These two themes are related to the two cultural conditions of collective efficacy and trust in the proposed model. Two additional themes of students' best interest and culture of high expectation emerged. While explaining these two new themes, I will justify why these two themes were categorized as cultural themes. The following sections will explain each of these cultural themes.

High perception of collective efficacy. A high perception of collective efficacy was echoed in interview responses of these two instructive cases as a supporting condition of collaboration. Collective efficacy beliefs are teachers' judgments about their own capabilities as a group to plan and implement the course of actions that are required to produce specific goals in specific context (Goddard & Hoy, 2004). Teachers in this study maintained a high perception about their colleagues' skills, knowledge and abilities

to teach and reach team's goals. A 6th grade teacher who had worked in other schools

proudly spoke about the high quality of teaching at her current site:

> Teachers here are top notch. I did my student teaching in a different
> district and I got my job offer here and I am so glad because the quality of
> teachers here is so amazing. There is no teacher that I would ever hesitate
> to say she/he is not a great teacher." (641)

The high quality teaching was also brought up by the 7th and 8th grade interviewees. A

 new teacher who taught both 7th and 8th grade proudly shared, " It's nice to work with

colleagues who are skilled and knowledgeable."(712). An 8th grade teacher who

perceived all the teachers at her team to be very capable commented, "The skill level at

this site is very high, whenever we set goals for our students we believe we could reach

them." (844).

Teachers' high perception of their colleagues' teaching skills particularly surfaced

while they spoke about serving students with diverse background:

> We have the mentality that yes, we have some impoverished kids, some
> minorities, some linguistic misalignment, whatever, but overall we just do
> with what we're dealt with. What we accomplish here with our students
> speaks to the high level skills of our teachers. (642)

These teachers felt that, in spite of many challenges they had, the student

achievement in mathematics was high due to the superior teaching quality at their site.

These responses demonstrate the strong collaborative teams perceive their colleagues to

be skilled and capable of reaching high goals for students. This finding supports the

literature in that a high level of collective efficacy is related to a high degree of

collaboration in schools (Bryk & Schneider, 2002; Daly, 2004; Tschannen-Moran, 2004).

The impact of high perception of collective efficacy on individual teaching.

High perception of collective efficacy in these two schools influenced individual teachers' efforts to perform at their highest level, **"**I think every teacher we have gotten here has followed the lead of people around them. It would influence them, this is how things are done and so I will be on the same system." (742). Another teacher who represented the majority of opinions in her 6th grade team stated, "If you are at a school where everybody is thought to be good you'd better be good. It's like you don't want to be the bad one at the good school."(612)." Such comments suggests that a high level of teachers' perception about their capabilities as a group exerts pressure and persuades individual teachers to behave and act in certain ways and improve their own teaching.

A robust sense of collective efficacy particularly motivated the new teachers to perform at their best. A new 7th grade teacher elaborated on the influence of her team on her performance, "It's a good pressure though because when you know that your colleagues are performing at a high level, you don't want to let them down. I want to be right there at the bar with them and they're pushing me." (644). Similarly, several participants from the same team considered their colleagues to be a motivating factor in their success as a teacher:

> You know when you're surrounded by hardworking people who have a
> similar goal and are capable, then it just pushes you. You want to do better
> for yourself, for them, for the department, for your school as a whole. So
> of course, it fuels you to want to get better. (643)

Another 7th grade teacher commented on the role of her peers as a motivating factor on her performance, " I think because we have so many good teachers it makes you want to

become better, it really does." (711). Hence, individual teaching improvement was a

product of high collective efficacy perception in these two schools.

It is important to note that although participants felt their individual teaching

improved as a result of high collective efficacy, the individual efficacy remained low and

did not show a positive correlation with the collective efficacy. This finding matches

with the finding from the quantitative part of the study. This might be due to the fact that

teachers in this study perceived their strengths and capability more as a group and not so

much at the individual level.

The importance of trusting relationships. While all interview responses reflected

that high collective efficacy was a supportive condition of collaboration, the interviewees

recounted trusting relationship, as the most important supporting condition of their

collaboration. Willingness to collaborate and participate in productive teamwork

depends on individual's trust in others and perceived trustworthiness (Brown &

Scottpoole & Rodgers, 2004; Daly, 2009). The participants stated that trusting

relationship helped them to increase their willingness to meet on their own more

frequently. A 7th grade teacher commented, " If we didn't trust each other we wouldn't

want to meet all the time on our own." (742). Similarly, another teacher commented, " If

I have good relationship I would want to spend more time and collaborate more with my

colleagues." (611). These responses demonstrated that while trust in general was an

important condition for collaboration, different facets of trust were independently

important.

Individual or group willingness to trust another party is based on the confidence

that the latter party will possess benevolence, reliability, competence, integrity openness

and respect (Daly, 2009; Hoy & Tschannen-Moran, 1999). I will use four of these characteristics to explain how and why trust improved the quality of collaboration in these two instructive cases. While the interview responses revealed that trust was a critical supporting condition, the four facets of benevolence, openness, reliability and competence emerged as subthemes and explained how and why trust was a supportive condition of collaboration. It is important to note that while these facets of trust surfaced in all interview responses; they overlapped particularly the two facets of benevolence and openness. Thus, in effort to have a better understanding of these four facets, I will separate each with the acknowledgement that they overlap.

Feeling safe to be transparent. An overwhelming number of teachers stated that they felt safe to be transparent with their fellow teachers due to the fact that they trusted each other. An 8th grade teacher who represented the opinions of teachers in her team commented, " If we didn't trust each other, we wouldn't ask our colleagues to come to our classrooms." (841). A new teacher who felt observation was a good way to improve her teaching practice commented, " My colleagues are not the type of people who would look down on me because I struggle with a certain area of teaching, so I think I would still be okay with them coming in because I don't see them as the judgmental." (712)

In particular, a new teacher who had been in other districts shared her perception about trusting relationships:

> I am not going to a person that I don't feel comfortable with or I don't
> have a good relationship with. I am going to go to somebody that I don't
> feel is going to be judgmental, which I can trust, who is going to give me
> feedback and not criticism. I think those impact collaboration the most.
> (711)

Such understanding that collaboration should be nonthreatening and nonjudgmental was echoed in the comment made by the newest teacher in the study who was particularly cognizant of the importance of trust in visiting each other's classroom, " It's just because we have had a more personal relationship, so I feel more comfortable making mistakes in front of her." (712). Teachers were more willing to participate in the observation process and open themselves to constructive criticism knowing that their safety would not be jeopardized. This common theme relates to the benevolence facet of trust as suggested in the literature review. The benevolence is the confidence that one's well being will not be harmed by the trusted party—even when the opportunity is available (Hoy & Tschannen-Moran, 1999). The understanding of benevolence aspect of trust is important because it explains why teachers feel safe to share information and open up their rooms to their colleagues. The benevolence aspect of trust helped these teachers to accept vulnerability to their peers with the expectation that there would be no ill will.

Constraints of feeling safe to be transparent. Aside from the proud moments of discussing the benevolence aspect of trust as a supportive condition for their collaboration, concerns about personnel issues arose several times during the interviews. Personality conflicts sometimes created a feeling of being judged and got in the way of visiting each other. A 6th grade teacher in the study shared one of her previous experiences about a colleague who made her feel uncomfortable, " There was one I didn't care for because I felt this person judges me all the time anyway. So I didn't need to give her that extra opportunity for that." (611). Differences in personality created tension between these two teachers and prevented them from working together.

Personality issues also got in the way of sharing ideas and strategies. Teachers referenced those with controlling personalities as an intimidating factor preventing the less aggressive ones from sharing. A new teacher who thought sharing ideas and strategies is an effective way for teacher learning stated, " There are some really strong personalities in the math department that kind of take over sometimes and that sometimes stops the more quiet ones from sharing." (712). Teachers with less controlling personalities did not feel comfortable sharing their ideas because they felt they might be confronted with judgments and criticism.

Open to share struggles. The participants in the study observed each other's teaching, expressed their problems, and shared information about what they were doing in their classrooms, making themselves vulnerable to criticisms from their peers. A new teacher who felt she could share her struggles and make herself vulnerable commented on why she felt safe to open up:

> Maybe because she shares a lot of her struggles too, so I know that she's
> not perfect and she has things she is working on as well. So I don't feel
> like it's so terrible when I have struggles and it is O.K. to show her my
> struggles. (811)

What helped these teachers to make themselves vulnerable to their peers was the personal care they had for their colleagues. The participants concurred that personal care for each other helped them become more open leading to more sharing, " We all want each other's success. Everyone here is willing to share struggles because we all look after each other." (643).

Similarly, it was noted by another 6th grade teacher who represented the perception of the majority of teachers in her team, " So it is not just these are people I

work with. These are people I have personal ties as well, so nobody is going to take

advantage of someone's struggles." (644). This commitment to caring about each

other's success beyond the workplace was echoed by 7th/8th grade teachers as well, " You

know, you're talking about people who – we're not just teachers. You know we care, we

know about each other's lives and everything." (7th/8th 4). Teachers' personal care for

each other beyond the workplace helped them to accept more vulnerability and feel safe

to open up with their peers. As the literature review suggests, openness is the process by

which people make themselves vulnerable by sharing information with others (Daly,

2009; Hoy & Tschannen-Moran, 1999). From this perspective, the openness aspect of

trust, which overlapped with the benevolence facet, helped teachers to manage the

uncertainty and risks associated with sharing struggles and maximize the benefits of their

collaborative work.

  The importance of relying on colleagues. The extent to which one can count on

another individual to provide what is needed (Hoy & Tschannen-Moran, 1999) is the

reliability facet of trust. This aspect of trust was reiterated in interview responses as an

important cornerstone of trust. Teachers felt they could rely on each other for help all the

time, "My colleagues are fabulous and super helpful. I can go to any of them and get

what I need anytime." (713). Another teacher from a different team commented about her

reliance on her colleagues in regards to strategies, " If I am struggling with teaching a

concept I can always ask my peers." (643). Not only did teachers rely on their peers for

teaching strategy, they relied on each other for materials. A 6th grade teacher who felt

close to her peers captured the idea best, " If one of us is absent, we can pull out a lesson

and send it to the sub right away." (642). This idea was echoed in the responses of 7th/8th

grade teachers as well, "The three of us count on each other for everything." (42). Reliability was deemed essential for the development of trusting relationship by all interviewees.

High perception of colleagues' skills and knowledge. Teachers spoke about the role of their colleagues' knowledge and skills in fostering the growth of collaborative culture and in inspiring their continuing growth as professionals. A new teacher who has been working for two years with the math department at her site shared:

> I feel like I can come in anytime and say, "I have no idea what I'm doing, and teachers in my team will have a million ideas to help me, and that's amazing. I never had that at the other school that I worked at." (713)

Teachers were more willing to ask for help if they perceived their peers to be skilled and knowledgeable. Getting feedback from fellow teachers who were perceived skilled was cited as an essential aspect of teacher learning. A new 7th/8th grade teacher who highly valued her peer's teaching knowledge shared, "Yeah, she was really good and I definitely learned a lot from her feedback. I may not have necessarily liked it but it was very helpful feedback, it was constructive criticism." (13). In particular, one new 7th grade teacher who has been in other districts shared her experience, "I think most teachers here are skilled and secure enough to come up with solutions. I always feel I can go to them and find some kind of answer to my problem." (741). A new 8th grade teacher captured the idea best when she said, **"**Everybody is really knowledgeable here and I really like it, I mean I take more advice knowing that my peers are really good at what they do." (812). Teachers in these two schools recognized the strengths of their colleagues and the role those strengths play in their paths to becoming better teachers.

In thinking about the conditions that create strong collaboration, the interviewees spoke about the importance of a trusting relationship to find success. Particularly, the participants referenced the value of benevolence, openness, reliability and competence as essential to their success as collaborative group. The comment of an experienced teacher who thought she could always improve her teaching captured the four facets of trust best:

> I am not going to a person that I don't feel comfortable with I don't have a good relationship with. I am going to go to somebody that I don't feel is going to be judgmental who I can trust and rely for help who is competent and can give me constructive feedback and not criticism." (612)

In the next two sections, I will explain the new two themes of teachers' focus on students' best interest and culture of high expectation while providing reasons as why they were categorized as cultural conditions.

Teachers' focus on students' best interest. Interview responses overwhelmingly echoed deep concerns for doing what was best for the students. This theme was categorized as a cultural condition because it reflects similarity in the way teachers perceive their job and teaching. A 6th grade teacher in the study passionately expressed her commitment to the bottom line of caring for students, " Everybody here has the same goal in mind which is what can we do best for the students and so with that goal in mind, we work well together." (642). Teachers' willingness to serve students' best interest helped them to overcome the constraints of time and personality differences. The following sections will explain how this theme helped teachers to cope with these two constraints.

Effect of students' best interest on constraint of time. A resounding theme among all interviewees as they answered questions about their experience with finding

time to collaborate was the common goal for students' best interest. Dedication to find time was deemed essential for the success of meeting this common goal. One teacher commented, " We care about kids, we want them to succeed, we really put lots of efforts to find time to meet." (643). Having students' best interest at heart came out in a conversation while a 7th grade teacher reflected upon why teachers spend their own lunch or before/after school time, "We can walk out the door at 2:40 but I don't think there is one teacher in our department who does that. We share all the same beliefs that students are first and foremost." (742). Essentially, these teachers saw their collaborative work through the lens of what is best for the students and put extra efforts to find time to get this work done.

   Effect of students' best interest on constraint of personality differences. This common goal was especially on people's minds given the different personalities within teams. On earlier discussions, when teachers brought up personality conflicts as one of the constraints of active learning, the idea of focusing on common goal for students created a bond between teachers and helped them to set aside their differences and focus on their common goals. An experienced 6th grade teacher representing overwhelming opinions discussed the importance of having common goal, " We all believe that we're all here for the kids, and I think that carries over. You know if there are things about different personalities, that doesn't matter, who cares because our common goal is those kids." (641).

   With this common goal in mind, teachers became more persistent dealing with personality differences. This idea was best captured in the response of a 6th grade teacher, " We can all have personality differences, but we all care about kids and we want

them to succeed that matters the most." (612). Teachers felt, regardless of their personalities, it was important to focus on caring about the welfare of the kids. Several mentioned that being willing to do what is best for students regardless of their differences has served them well. " There's going to be issues, but I think overall everybody has the same goal in mind which is what can we do best for the students." (644). This attitude and approach to collaboration in these two cases supported their paths because it allowed them to overcome issues related to differences.

In sum, although time and differences in personalities were found to be constraints of collaboration, teachers in these schools recognized the importance of working together toward a sense of shared responsibility for students' best interest. For these teachers a willingness to agree on common goal, setting aside the individual differences, focusing on team's goal, actively taking time to meet whether it is forced or not were contributing factors to the success of their collaboration. The next section will explain another theme that was categorized as cultural theme as well.

Culture of high expectation and collaboration. The importance of getting everyone on board with their school's high expectation for teaching and learning was referenced in the responses of both teachers and administrators. This theme was categorized as a cultural theme because it involved the way staff perceived teaching and learning. A 7th grade teacher who thought it was important to do whatever it takes to reach the school's goal stated, " We have a core of people who are willing to work hard and meet school's high expectation for teaching and student learning." (741)

Several teachers mentioned the principal's role in communicating schools' expectation to the staff and getting everyone on board. One stated, " He always reminds

us why we are here and what are the expectations for student learning." (641). This idea

was best captured in a 7th grade teachers' comment who linked the school's high

expectation to reaching all students, " So I feel that as a whole, our staff is reaching the

majority of our students, and if we aren't, our principal will broach the topic of how do

we make sure that every child is learning." (713). Principals in these two successful

schools supported the school's expectation for teaching and learning by providing staff

with opportunities to present and share ideas on how to reach all students during staff

meetings. An experienced teacher who valued her principal's support stated, "During our

staff meeting, our principal always asks us to share different strategies to help student

learning." (811)

Principals connected the idea of school's high expectation to students' best

interests. The principal at School 4 stated, " I explain to teachers the importance of the

work they do and the fact that we are here for kids." The other principal at School 1 felt

it was necessary to keep connecting the school's expectation to the idea of students' best

interest:

> We've had some teachers complaining about this or that and I just sit up in
> front of everybody and say, " It's not about you, it's not about me, it's
> about the kids, so get over yourself. (41)

These responses link the two ideas of high expectation for teaching and learning

with the idea of focus on students' best interest. The administrators in these two schools

communicated school's expectation on a continuous basis and kept the energy level high.

These responses by the administrators also explain why focus on students' best interest

emerged as a dominant theme in teachers' interview data.

A culture of high expectation for teaching and student learning in these two schools had power to motivate teachers to change behaviors related to effort and persistence. An administrator commented, " This is how our school works and teachers realize if they want to stay in our school, they have to live up to this high level expectation." (12). A school's high expectation for successful teaching and student learning elevate a sense of high expectation for individual teachers and teams. This high expectation in turn affects the diligence with which teachers choose to pursue their common goal of students' best interest leading them to put forth the effort required to achieve strong collaboration.

Summary of Qualitative Study

As table 21 indicates, the interview response analysis showed the six structural themes as important factors of collaboration: length of time, teacher learning through collaboration, focus on content knowledge, focus on teachers' daily goals, participation of teachers of the same grade level, and physical proximity. The interview analysis also identified the four cultural themes of high perception of collective efficacy, the importance of trusting relationships, students' best interest and culture of high expectation as important supportive conditions of collaboration.

Although the literature does not suggest that the cultural and structural conditions are quite independent, it offers few studies that show the interaction between these conditions. One of the intents of this study was to investigate the interactions between these conditions, and as the findings indicated these conditions are actually highly

dependent and interdependent. The quantitative phase of this study revealed the same finding in that the structural and cultural conditions are highly interactive.

Pertaining to the constraints of collaboration, the qualitative phase found that lack of structured time and differences in personalities were constraints of collaboration. Although these two constraints were mentioned, it seemed that teachers in these instructive cases overcame these constraints by working together toward a sense of shared responsibility for students' best interest. The responses also showed that teachers' perception of their learning was highly interactive with their perception of structural and cultural conditions.

Table 21. Results of Qualitative Data

Purpose	Findings
Research Question 1: What are the structural and cultural conditions of reform PD that support or constrain mathematics teachers' collaboration in a middle-school setting?	Interview responses identified six structural themes of length of time, focus on content, focus on teachers' daily goals, teacher participation of same grade, and physical proximity as supportive conditions and four cultural themes of trusting relationships, collective efficacy, students' best interest and culture of high expectation as supportive cultural conditions. Lack of structured time and personality differences were the constraints.
Research Question 2: What is the interaction between collaboration, structural and cultural conditions in highly effective cases?	The analysis of interview responses revealed structural themes are interconnected, cultural themes are interconnected, structural, and cultural themes are highly interconnected and overlap.
Research Question 3: What are teachers' perceptions of collaboration and its influence on their teaching?	The analysis of interview responses revealed that teachers feel their collaboration has helped them to learn more about teaching and improve their instructional practices

Interaction between structural and cultural conditions. The findings of both

the qualitative and quantitative phases of the study showed that structural, cultural and

teaching practice constructs were highly interconnected. The results of correlation

analysis indicated that structural constructs such as coherence, content, duration and

active learning were positively and significantly correlated with teaching practice. The

analysis of interview responses revealed the same finding in that that these structural

factors were positively interactive with teaching practice. The findings of the correlation

table also indicated the cultural conditions of collective efficacy and trust were positively

correlated with teaching practice, indicating that cultural factors positively influence

teaching practice; the interview responses showed the same finding. More importantly,

both the correlation table results and interview analysis showed that all the structural

conditions were positively correlated with cultural conditions suggesting that the

structural and cultural conditions are highly interdependent.

Although there were many interactions between the structural and cultural

themes, the following section will highlight some of the more dominant interactions

between the structural and cultural themes (Table 22). Since, through interview

responses, it was shown that duration and active learning interact with the other structural

factors of content, coherences and collective participation, we could conclude that trust

and collective efficacy indirectly interact with these structural factors.

Table 22. Summary of Interactions Between Structural and Cultural Themes

Interaction	Findings
Length of Time and Trusting Relationship	High interaction
Teacher Learning and Trusting Relationship	High interaction
Teacher Learning and Collective Efficacy	High interaction
Trusting Relationship and Collective Efficacy	High interaction

Interaction of length of time and trusting relationship. All the participants felt

that with trusting relationship they would spend their own time during lunch, before

school, after school and even on weekends to collaborate, "And even with that I will meet

on Sunday morning, and I don't mind doing that because to me good relationship is far

more important." (612). The benevolence facet of trust explained why teachers met on their own time. A 7th grade teacher felt eating lunch with her colleagues gave her a chance to share her problems in a non-threatening environment. " We have lots of informal meeting during lunch. We eat lunch together everyday because we like each other, it's wonderful to eat and share struggles with people you feel comfortable with." (644). Teachers ate lunch together because they had trusting relationships and while they ate lunch they discussed their problems. By meeting during lunch every day, the duration of teacher collaboration extended throughout the year.

The competence facet of trust was echoed in teacher responses as well, and teachers explained why they collaborated on their own time. Meeting before and after school was a common approach to collaboration because teachers perceived their peers to be skilled and knowledgeable and wanted to learn from their fellow teachers. A 7th grade teacher spoke highly about her peer's expertise while she was explained why she met with her every day after school, "Oh God yes. I always meet her after school to see what she is doing on next day. She always comes up with these wonderful lessons, and I want to know what they are so I can do the same thing. " (741). The benevolence and competence facets of trust influenced teachers' desire to consistently collaborate beyond their time embedded in the day throughout the year.

Interaction of teacher learning and trusting relationship. In this study, a trusting relationship supported teachers sharing and visiting as two ways of active learning. In regards to sharing, a teacher commented, " Because of trust, we have open dialogue and lots of problem sharing." (644). With the benevolence aspect of trust, teachers became transparent about the problems they experienced in their classrooms and

showed more willingness to conduct discussions with others in search of solutions. The benevolence facet of trust explained how trust interacted with the learning of a 7th grade teacher, " I feel totally comfortable going to her and saying, "You know what? The way I am teaching it, my students aren't getting it. I need to know how you are teaching this concept." (712). The benevolence facet of trust helped this teacher to show her vulnerability, share her struggles and learn how to improve her teaching practice.

The benevolence facet of trust also influenced teachers' desire to visit each other's classroom as another way of active learning. A new teacher who thought visiting other teachers was a good way to improve her teaching shared, " It really would depend on my personal relationship with the teacher, whether I care or not I would visit her class or invite her to my class." (711).

While discussing the role of trust in teacher learning, participants repeatedly brought up the idea of competence facet of trust and how it influences their desire to learn from their peers. Teachers stated that they were going to be a part of learning process with someone whom they considered to be competent. This idea was noted by a 7th grade teacher who found more value in the feedback of a colleague who was knowledgeable, " Although it may hurt, I prefer to get feedback from a colleague who I consider to be a good teacher." (641)

The interaction of teacher learning and collective efficacy. Teachers' high perception about their colleagues' capabilities influenced their desire to learn and improve. An 8th grade teacher who held high regard for her team's competency stated, " I want to learn from every one of these ladies because I know how great they are with their students. I see what they can do and I want to do the same. " (842). Another

teacher who highly valued his team's teaching knowledge commented, " Collaborating with my colleagues gives me an arsenal in my quiver of arrows to teach well, to reach more kids and to not only just improve practice, but to better my classroom management. (643).

High perception of collective efficacy influenced teachers' decision for classroom observation as well. A 7th grade teacher who felt classroom visitation was a valuable learning tool shared, " I want to observe strong teachers because I know I can learn more from them." (712). The desire to get feedback from peers who were perceived competent was rooted in gathering opinions and perspectives as well, " I am always asking him to stop by and observe how I am teaching. He is such a good teacher and I know I can use his feedback to make my lesson better." (611)

Every interviewee mentioned the value of a trusting relationship and high perception of collective efficacy as significant reasons for their willingness to collaborate beyond their time embedded in the workday. These participants collectively engaged in the active learning process with a focus on content and connected activities.   Hence, trust and collective efficacy influenced the structural factors of collective participation, duration, active learning, content, and coherence in these two schools. The following section will explain the interaction between the two phases of this study.

Considering Interaction Between Qualitative and Quantitative Data. As we look across this study's qualitative and quantitative results, major crosscutting themes emerge as the most aligned between the two methods. As Table 22 indicates, in response to the first research question, quantitatively, teachers in instructive cases of collaboration reported structural conditions of duration, coherence, active learning, content, collective

participation along with cultural conditions of collective efficacy and trust were supportive conditions of collaboration. During the interviews, this finding was solidified through dominant structural themes of length of time, teacher learning, focus on content, focus on teachers' daily goals, participation of teachers of the same grade level and cultural themes of high perception of collective efficacy, trusting relationships, students' best interest and culture of high expectations.

In response to the second research question, surveys pointed to positive correlations between all the constructs. As the correlation table in the quantitative phase showed, the structural factors were positively correlated, the cultural factors of collective efficacy and trust were positively correlated, and more interestingly the structural, cultural and teaching practice factors were positively correlated. The analysis of interview responses revealed that structural and cultural conditions were actually interconnected and interrelated. The individual efficacy in both parts of the study did not appear to be a contributing factor to collaboration in strong cases of collaboration. Both quantitative and qualitative analysis showed that there was a weak correlation between individual efficacy and the other conditions.

In response to the third research question, the quantitative phase showed that structural and cultural conditions were positively and highly correlated with teaching practice constructs, suggesting that teachers who scored high with supportive conditions had a high perception about their teaching practice. The qualitative phase also showed that the structural and cultural conditions were interconnected with teaching, learning, and improvement of instructional practice. This suggests that teachers who had a high perception about time spent, trust, and collective efficacy had a high perception about

their own teaching.

Table 23. Interaction Between Quantitative and Qualitative Data

Purpose	Findings of Quantitative	Findings of Qualitative
Research Question 1: What are the structural and cultural conditions of reform PD that support or constrain mathematics teachers' collaboration in a middle-school setting?	Factor analysis and Descriptive Statistics identified coherence, content, duration and active learning as supportive structural conditions and trust, collective efficacy and individual efficacy as supportive cultural conditions.	Interview responses identified six structural themes of length of time, focus on content, focus on teachers' daily goals, teacher participation of same grade, and physical proximity as supportive conditions and four cultural themes of trusting relationships, collective efficacy, students' best interest and culture of high expectation as supportive cultural conditions. Lack of structured time and personality differences were the constraints.
Research Question 2: What is the interaction between collaboration, structural and cultural conditions in highly effective cases?	Pearson correlation table pointed to the positive correlations between structural conditions, positive correlations between cultural conditions and positive correlations between structural and cultural conditions.	The analysis of interview responses revealed structural themes are interconnected, cultural themes are interconnected, structural, and cultural themes are interconnected and overlap
Research Question 3: What are teachers' perceptions of collaboration and its influence on their teaching?	Pearson correlation table showed that teachers' perception of their teaching practice (TP) is positively correlated with both structural and cultural conditions.	The analysis of interview responses revealed that teachers feel their collaboration has increased their learning and improved their instructional practices.

The interview responses revealed one additional structural theme of physical proximity and two additional cultural themes of students' best interest and culture of high

expectation. These additional themes added contribution to the existing literature and will be added to the original proposed model.

Chapter Summary

Through one-on-one conversations with successful collaborators in the two schools, this study found several themes about how these teachers enact their collaboration. In reviewing all of the qualitative data, ten major themes emerged. Six themes were related to the structural conditions, four themes were related to the cultural constructs. These themes are aligned with the structural and cultural constructs of the proposed model and the three research questions driving the study. Length of time as an important factor of collaboration, teacher learning, focus on teachers' content knowledge, focus on teachers' daily goals, participation of teachers of the same grade level and the importance of physical proximity were the major six themes related to the structural conditions of the study. The other four themes found in the interview responses were high perception of collective efficacy, the importance of trusting relationships, students' best interest and culture of high expectation, which related to the cultural conditions in the study. The high perception of collective efficacy and the importance of trusting relationships were related to the cultural conditions of the proposed model. One additional structural theme of physical proximity and two additional cultural themes of students' best interest and culture of high expectation added contribution to the existing literature and will be added to the original proposed model. The findings indicated that the structural, cultural and teaching practice constructs were all highly interconnected. Thus, the proposed model differs in two ways: one it includes three additional constructs

and two this model is much more interactive than we may have originally thought.

Chapter five will provide more elaboration on the revised model.

Chapter Five: Discussion and Conclusion

This chapter presents a summary of this study including an overview of the problem, purpose statement and research questions, a review of the methodology, and a summary and discussion of the findings. Additional sections discuss implications for practice, future research and the limitation of the study.

Summary of the Study

Overview of the Problem. As stated in Chapter One, for the past two decades, the mathematical achievement of American students has been a major concern. A portion of the achievement gap on the National Assessment of Educational Progress and other standardized assessments might result, in part, from teachers with less mathematical knowledge teaching more disadvantaged students (Haycock, 1998). To address this issue, a number of reforms and policies have been put in place to increase teacher effectiveness and student achievement. One of the most promising approaches to increase teacher effectiveness and student achievement has been through teacher collaboration. Collaboration as a response to systematic reform efforts has potential to increase teacher's content knowledge and effectiveness (Birman et al., 2000).

This sense of urgency has led researchers and practitioners to examine conditions that create effective collaboration in mathematics. A review of the relevant literature shows teacher collaboration may be one way to enhance teaching practice and narrow the achievement gap (Ball et al., 2005; Drago-Severson & Pinto, 2006; Lieberman, 2009; Margolis, 2008; Zwart, Wubbles, Bergen, & Bolhuis, 2009).

The relevant literature showed that in order for collaboration to be effective, it

should be supported by specific structural and cultural conditions. Structural conditions of coherence, content, active learning, duration, and collective participation influence the outcome of collaboration (Birman et al., 2002; Jeanpierre et al., 2005;Johnson et al., 2007; Penuel et al., 2007). The literature also revealed that cultural conditions of collective efficacy, (Bryk & Schneider, 2002; Daly, 2004; Tschannen-Moran, 2004) individual efficacy (Lantner, 2003) and trust (Brown & Scottpoole & Rodgers, 2004 & Daly, 2009) impacted the strength of collaboration. While the structural and cultural factors have often been argued, empirical studies that show the importance of the combination of structural and cultural conditions on collaboration are limited. There are studies connecting structural factors to collaboration and studies showing the relationship between cultural factors and collaboration, but only a few studies linked both structural and cultural factors to collaboration in mathematics. Therefore it is informative to investigate possible links between collaboration and the combination of both structural and cultural factors in light of empirical evidence.

This study identified the structural and cultural conditions in two high performing cases of collaboration and investigated the interactions between these conditions and teachers' perception on collaboration and its influence on their teaching.

Purpose Statement and Research Questions. The purpose of this study was to explore the supportive structural and cultural conditions of collaboration, which have been identified in the extant literature as critical conditions for improving the outcomes of collaboration for teachers. However, the relationship among these factors has remained understudied. This study not only explored the supporting structural and cultural conditions but it also investigated the interaction between these conditions in

highly effective cases. The study also provided an opportunity to examine teachers' perception of collaboration and its influence on their teaching. This study proposed a new theoretical framework (described in chapter three (Figure 1) which linked effective collaboration to both structural and cultural conditions and the interaction between them. This proposed framework was supported by the results of this study, creating a new lens through which to view teacher collaboration. This new framework or model demonstrates the crucial role that the combination of both structural and cultural conditions plays in enhancing the effectiveness of collaboration in mathematics. This model also highlights the interconnection between structural and cultural conditions. As such, this study was effective in answering the research questions:

1. What are the structural and cultural conditions that support or constrain mathematics teachers' collaboration in a middle-school setting?

2. What is the interaction between collaboration, structural and cultural conditions in high performing cases?

3. What are teachers' perceptions of collaboration and its influence on their teaching?

Review of the Methodology. As detailed in chapter three, this study used a mixed-methods (Rudestam & Newton, 2007) embedded case study design (Yin, 2003, Creswell, 2008) consisting of two phases. The first phase was quantitative and utilized survey data containing demographic information, questions on structural, cultural and teaching practice constructs. This was a population study of 6th, 7th, and 8th grade mathematics teachers and administrators from one middle school in district A, and three middle schools in district B. The first phase of this study addressed the three research

questions posited and the selection of two instructive cases of collaboration. Descriptive Statistics, factor analysis, correlation, and ANOVA tests were used to address the three research questions and the selection of two instructive cases of collaboration.

The purpose of the second phase was to delve more deeply into the quantitative data and increase the comprehensive nature of the overall findings in regards to the three research questions. The qualitative part of the study included interviews with 6th, 7th and 8th grade mathematics teachers at two instructive cases of collaboration with the purpose of giving voice to their experiences and perceptions as teachers. Additionally, four administrators in the same two schools were interviewed to share their perception on supporting and constraining conditions of effective collaboration. Transcribed interview data were manually coded. Both quantitative and qualitative results of the study were reported in chapter four.

Findings of this study revealed six major ideas that cut across the three research questions. The following sections will discuss and interpret each major idea according to the themes that emerged from its analysis. The literature that addresses each theme is also discussed to help explain the results and the theoretical implications that the findings may have on the field of educational leadership. Finally, the results are applied to make recommendations to practitioners and policymakers.

Discussion of the Results

From this study, six major concepts emerged. First and foremost, structural and cultural conditions exist independently in high performing cases of collaboration. Second, collective efficacy and shared goals for students are the catalyst for the

development of structural conditions. Third, trust is the most important predictor of

collaboration. Fourth, teachers of instructive cases of collaboration have a high

perception about their teaching practice. Fifth, there is a strong interaction between the

structural and cultural conditions in high performing cases of collaboration. Sixth, in

high performing cases of collaboration, teachers mostly engage in informal collaborative

activities based on their own needs, willingness and time. The following sections will

discuss each of these concepts.

Structural and Cultural Conditions Exist Independently in High Performing

Cases of Collaboration. Both the quantitative and qualitative portions of this study

identified supportive structural and cultural conditions that exist independently in high

performing cases of mathematics collaboration in middle school setting.   The following

sections will discuss the supportive structural and cultural conditions that were identified

in this study.

Supportive Structural Conditions. This study confirmed that structural

conditions support collaboration in high performing cases. The analysis of interview

responses revealed six structural themes: time as an important condition of collaboration,

focus on teachers' daily classroom goals, focus on teachers' content knowledge, teacher

learning through collaboration and participation of teachers of the same grade level.

These structural themes parallel the structural factors of duration, coherence, content,

active learning and collective participation as found in the literature review (Birman et

al., 2002). This finding is consistent with previous literature in that high performing

collaborative teams evidence five structural characteristics of duration, coherence,

content, active learning and collective participation (Birman et al., 2002; Jeanpierre et al.,

2005; Johnson et al., 2007; Penuel et al., 2007). The following sections will briefly unpack each condition.

Time as an important condition of collaboration. This study shows that sufficient time is a critical factor in high performing cases of collaboration. However, the sufficient time in this study mostly came from teachers' own informal time and not from the formal time provided by the school. The survey and interview responses indicated that structured time provided by the master schedule did not allow teachers sufficient time to discuss curriculum, share lessons and visit each other for the purpose of discussing lessons and student needs. This provides a possible explanation of why the finding of the quantitative phase showed that the duration construct was not as high as the other constructs. The duration construct on the survey instrument questioned teachers whether they were provided with a regular structured time to meet, and as the interview response showed, the master schedule did not provide teachers with sufficient time to collaborate As indicated in the interviews, teachers reported that the majority of their collaboration occurred on their own time during lunch, before or after school. Since teachers willingly spent their own time to collaborate, the duration was long enough to provide teachers with opportunities to focus on content and benefit from active learning. Previous studies identified duration as an important condition of collaboration (Birman et al., 2002), and this study confirmed duration as a critical condition as well.

Focus on teachers' daily classroom goals. The interview responses across both schools revealed that the activities of participants' collaboration were connected, relevant to teachers' everyday work, and were consistent with participant's daily goals. This theme parallels the coherence factor suggested by previous studies in that the activities of

strong collaboration are coherent, consistent with teachers' goals, build on previous activities, and are followed by additional activities. (Birman et al., 2000). Teachers in this study consistently met and discussed their daily goals, outcomes of the lessons they had planned together and the effectiveness of teaching strategies they had implemented. These connected activities improve teaching practice and knowledge because they relate to teachers' everyday classroom instruction and pedagogy (Birman et al., 2000; Strahan & Hedt, 2009).

Focus on teachers' content knowledge. The collaboration of teachers in this study focused on content—it increased teachers' understanding of a specific mathematics concept or the way students learn a specific concept. The findings indicated that the degree to which teachers focused on content was positively related to teachers' reported increase in learning and teaching practice. This finding is consistent with the previous studies that document the profound importance of content on collaboration and teaching practice (Birman et., 2002 &Cohen & Hill, 1998). The two instructive cases of collaboration in this study are examples not only of a daily goal aligned collaboration but also of a collaboration, which focuses on standard based content.

Teacher learning through collaboration. In this study, teachers' collaboration included opportunities to observe and be observed, share strategies, develop and implement lesson plans. This finding supports the literature review in that active learning—another structural condition— provides opportunities for teachers to become engaged in observation, meaningful discussion, planning and practice as part of the collaboration activity (Liberman, 1996; Loucks- Horesley et al., 1998). As a result of their active learning, teachers in this study reported increased knowledge and enhanced

teaching practice.

Participation of teachers of the same grade level. In this study, the collective participation of teachers from the same grade level and content gave teachers the opportunity to discuss shared concepts and integrate what they learn from their content discussions. This finding supports the literature in that teachers who teach the same grade and content are likely to share common curricular materials and course offerings (Birman et., 2002). Collective participation of teachers in this study helped them to develop a common understanding of instructional goals, teaching strategies, and solutions to problems.

Physical proximity. One additional theme of physical proximity was found as a supportive condition to collaboration. The interview data suggest that teachers had a greater tendency to engage in collaborative behaviors when they had a closer physical proximity. Considering the tensions between lack of time and the need to meet, this finding suggests it is important to make classrooms of teachers teaching the same content and grade in the same proximity.

Supportive Cultural Conditions. The findings of both parts of this study pointed to a high level of collective efficacy and trust as supportive conditions in the two instructive cases. Two additional themes of focus on students' best interest and culture of high expectation emerged from interviews. The findings pertinent to collective efficacy and trust support the previous literature review in that a high level of collective efficacy and trusting relationship positively influence the outcome of collaboration (Bryk & Schneider, 2002; Daly, 2004; Tschannen-Moran; Goddard & Hoy, 2004).

However, unlike the literature, which suggests the importance of individual

efficacy as a supportive condition, this study did not find a strong correlation between individual efficacy and collaboration. Both the qualitative and quantitative portions of the study indicated that individual efficacy was not as high as the other cultural conditions. Furthermore, this study did not replicate other studies that indicate a strong sense of collective efficacy enhances teachers' self-efficacy beliefs while weak collective efficacy beliefs undermine teachers' sense of efficacy (Goddard et al., 2004). Although interview responses showed that high perception of collective efficacy influenced individual teachers' efforts to perform at their highest level, the finding of this study showed a weak correlation between individual and collective efficacy. The analysis of interview responses provided a possible explanation as to why individual efficacy remained low and did not show a strong positive correlation with collective efficacy.

The interviews revealed that due to the strength of teacher collaboration in these two instructive cases, teachers mostly relied on their collective capability to solve problems and maintained a lower perception of their own capability when it came to dealing with issues. This may be an indication of teachers' reliance on their colleagues to solve problems as a result of their strong collaboration. As the interview responses indicated, the reliance facet of trust was high in both cases, and this high level of reliance on colleagues may have actually lowered teachers' perception of their own capability to solve problems leading to lower individual efficacy. In large part, this may be due to the fact that teachers feel empowered when working in collaboration to determine how to best instruct and support students and their learning.

Through the interviews, the idea of cultural conditions emerged as critical foundation for the development of structural conditions required for high performing

collaboration. Thus, the following sections will unpack each of these ideas and how they facilitated the development of other conditions.

The importance of Collective Efficacy and Shared Goals on High Performing Collaboration. Cultural conditions of collective efficacy and shared goals for students were found to be the catalyst for the development of other structural conditions. Collective efficacy beliefs are teachers' judgments about their own capabilities as a group to plan and implement the course of actions that are required to produce specific goals in specific context (Goddard & Hoy, 2004). Teachers in this study maintained a high perception about their colleagues' skills, knowledge and abilities to teach and reach team's goals.   As a result of this high perception, they asked for help more often and found more value in peers' feedback and expertise to solve problems. This resulted in more active learning for teachers. Thus, collective teacher efficacy strongly predicted commitment to collaboration and enhanced teaching practice.

Another outcome of this study was a commitment to serving students' best interests and having high expectations for student learning. As the participants shared their illustrations of their roles and work in collaboration with their peers, their true passion was situated within the essence of their classrooms and their students' best interest. Each participant proudly expressed that they would never allow any of their students to fail, demonstrating a dedicated responsibility for the learning of all their students.

Culture of high expectation, another shared goal, referenced teacher behaviors that illuminate high expectations for student learning, teaching improvement, and high quality collaborative work. This study found teachers' and administrators' expectations

for both student and teacher learning were firmly in place. One example expressed by teachers at both sites was the principal's continual dialogue about student learning during staff meeting. Communicating school's high expectation of student learning to teachers on a regular basis made teachers focus more on learning strategies that could meet the needs of all students through their collaborative work. All participants, in sharing their experiences and work in a collaborative environment, indicated a shared vision and responsibility of student learning influenced their relationships and the quality of their collaboration.

The Critical Role of Trust in the Outcome of Collaboration. While all interview responses reflected that high collective efficacy and shared goals were important predictors for the development of structural conditions, the interviewees recounted trusting relationships as the most critical supporting condition of their collaboration. It is important to note that although the factor of total trust was a predictor in both high performing cases, what was of interest in this study was the impact of individual facets (Benevolence, Reliability, Competence, Integrity, Openness and Respect). The four trust facets of Benevolence, Openness, Reliability and Competence were common significant predictors across both cases. The finding of this study supports the relevant literature review in that while trust in general is an important condition for collaboration, different facets of trust are independently important. Individual or group willingness to trust another party is based on the confidence that the latter party will possess benevolence, reliability, competence, integrity openness and respect (Daly, 2009; Hoy & Tschannen-Moran, 1999). In this study, these facets of trust overlapped particularly the two facets of benevolence and openness. The next sections will explain

the important facets of trust that were found in the study.

Feeling safe to be transparent. An overwhelming number of teachers stated that they felt safe to be transparent with their fellow teachers due to the fact that they trusted each other. The findings showed that teachers were more willing to participate in the observation process and open themselves to constructive criticism knowing that their safety would not be jeopardized. This finding relates to the benevolence facet of trust as suggested in the literature review. The benevolence is the confidence that one's well being will not be harmed by the trusted party—even when the opportunity is available (Hoy & Tschannen-Moran, 1999). For example, the participants in the study observed each other's teaching, expressed their problems, and shared information about what they were doing in their classrooms because they trusted their peers.

Open to share struggles. The participants in the study observed each other's teaching, expressed their problems, and shared information about what they were doing in their classrooms making themselves vulnerable to criticisms from their peers. Teachers' personal care for each other beyond the workplace helped them to accept more vulnerability and feel safe to open up with their peers. As the literature review suggests openness is the process by which people make themselves vulnerable by sharing information with others (Daly, 2009; Hoy & Tschannen-Moran, 1999). From this perspective, the openness aspect of trust, which overlapped with the benevolence facet, helped teachers to manage the risks associated with sharing struggles and to maximize the benefits of their collaborative work and improve their practice.

The importance of relying on colleagues. This study also suggests that with trust teachers were able to rely more on each other for help in regards to teaching strategy,

materials, or dealing with difficult situations. This finding supports the previous studies regarding the reliability facet of trust which is the extent to which one can count on another individual to provide what is needed (Hoy & Tschannen-Moran, 1999). This aspect of trust was reiterated in interview responses as important cornerstone of trust.

High perception of colleagues' skills and knowledge. The findings indicate that high perception of colleagues' skills and knowledge, a competence facet of trust, influenced the participants' desire to collaborate with their colleagues. Teachers in these two schools recognized the strengths of their colleagues and the role those strengths play in their paths to becoming better teachers. Teachers spoke about the role of their colleagues' knowledge and skills in fostering the growth of collaborative culture and in inspiring their continuing growth as professionals. Teachers were more willing to ask for help if they perceived their peers to be skilled and knowledgeable. Getting feedback from fellow teachers who were perceived skilled was cited as an essential aspect of teacher learning.

Most importantly, from both quantitative and qualitative results, we learned that duration of high performing collaboration depends on the amount of time teachers spend on their own time. Although there was a reciprocal and reinforcing relationship between teachers' trusting relationships and time they spent on their own to collaborate, the level of trust appeared to be a predictor of increased time. This conclusion suggests that helping teachers to develop trusting relationships may be the best pathway to reinforcing increases in time they spend on their own to collaborate. Thus, site leadership has a critical role in identifying strategies to develop and sustain a school culture that is based on trust.

This data indicates a high level of trust among teachers may create an environment in which teachers embrace the idea of sharing strategies and problems as well as going into each other's classrooms to observe as a way of learning and improving. With trusting relationships, teachers make it a habit to share ideas, instructional strategies, or teaching struggles with one another. This study shows that trust among teachers may support the exchange of strategies, information, resources and observations that can be accessed and leveraged to achieve school's shared goals.

The Critical Impact of Collaboration on Teaching Practice. The findings of this study showed that high performing collaboration produced high levels of instructional practice. The surveys and interviews revealed positive changes in teachers' pedagogical learning and effectiveness as a result of collaboration. In the surveys, teachers were asked to rate the change in their teaching practice on a scale of 1 (strongly disagree) to 6 (strongly agree). For the two instructive cases of collaboration, items related to teaching practice such as improvement in teaching strategies, increased effectiveness, increased teaching knowledge and impact on student achievement all yielded means of 5.03 or higher. Teachers in these two high cases of collaboration consistently responded favorably to the following survey items asking them about the collaboration's impact on their knowledge and practice: ''My teaching has improved as a result of collaboration; our collaboration has helped me to become more effective; I can note changes in my teaching because of our collaboration.'' Survey data indicating increased and improved math instruction are supported by interview responses as well.

The interview responses showed that improvement in teaching practice as a result of teacher learning was a critical characteristic in the instructive cases of collaboration.

The interview responses revealed increases in teacher pedagogical and math knowledge indicating that teachers increased the quality of math lessons as a result of sharing effective teaching strategies and observing each other. In interviews, when asked specifically about opportunities for teacher learning and about the impact of collaboration on their teaching practice, almost all teachers indicated that collaboration had a positive influence on their teaching. The participants stated that they shared teaching practice, learned together, and sometimes observed each other in order to improve their own instructional practices. Even teachers who did not have the opportunity to observe their fellow teachers, or to be observed by their fellow teachers, recognized the importance of observation and even remarked that they wished they had more time to observe more teachers. This willingness to be observed requires a great deal of trust on the part of the teacher as it was brought up in earlier section.

The Critical Importance of the Interaction Between Structural and Cultural Conditions. Both quantitative and qualitative investigations of the two instructive cases of collaboration found that although structural and cultural conditions are independently needed, they are both necessary due to the positive relations and interconnections between all constructs. The surveys indicated positive correlations and the interview responses showed strong interconnection between structural factors, cultural factors as well as between structural and cultural factors. The following sections will highlight some of the important relations and interconnections between structural conditions, cultural conditions and between structural and cultural conditions.

Interactions between structural conditions. The correlation table showed that structural constructs of coherence, content, active learning and teaching practice were all

positively correlated. For example the correlation table showed that as teachers spent more of their own time (coherence), they had more opportunity to discuss the curriculum (content) and increased their learning (active learning), which resulted in improved teaching practice. The analysis of interview responses not only confirmed these positive relations but it also revealed that all these structural conditions are highly interconnected. For example, teachers of the same grade level (collective participation) stated that the informal time they spent during lunch, before and after school (coherence) caused them to spend more time (duration) on discussing the curriculum (content), share best practices (active learning) and ultimately improve their teaching practice.

Interactions between cultural conditions. Trust and collective efficacy also showed positive correlation. The analysis of interview responses not only confirmed this positive correlation, but it also revealed that trust and collective efficacy are interconnected. With higher levels of trust, teachers collaborated more frequently on their own leading to better teaching and more classroom success. As a result of high level of success, teachers held higher collective efficacy beliefs. Thus, trust among teachers caused higher collective efficacy.

Interactions between structural and cultural conditions. The correlation table showed that trust and collective efficacy were positively correlated with other structural constructs. However, the interview responses provided a better understanding about the interconnection between trust, collective efficacy and all the other structural conditions. Every interviewee mentioned the value of trusting relationships and high perception of collective efficacy as significant reasons for their willingness to collaborate beyond their time embedded in the work day. These participants collectively engaged in the active

learning process with a focus on content and connected activities. Trusting relationships supported teachers' sharing and visiting as two ways of active learning. High perception of collective efficacy influenced teachers' desire to value peers' feedback, learn and improve teaching. Hence, trust and collective efficacy influenced the structural factors of collective participation, duration, active learning, content, and coherence in these two schools.

In sum, although the findings show a reciprocal connection between the structural and cultural conditions, during the course of the participants' interviews, the two cultural conditions of trust and collective efficacy were discussed as the fundamental characteristics that influenced the quality of structural conditions. Particularly, the participants voiced that trust was the catalysts for developing and maintaining high performing collaboration. Teachers' trusting relationship increased their willingness to spend more of their own time throughout the year, conduct ongoing dialogue about grade level curriculum, share strategies, receive valuable feedback and increase their teaching knowledge. The participants also believed that shared trust encouraged each of them to enhance their teaching practice through feeling comfortable to share and safely dialogue to determine effective approaches to teaching. This finding may be indications of the enormous influence of cultural conditions particularly trust on the development of structural conditions.

Informal Collaboration in High Performing Cases. The literature review suggested that teachers improve their teaching practice through formal collaborative models such as collective teacher inquiry, lesson study and PLCs in which school provides structured time. The findings of this study showed that teachers in high

performing cases of collaboration while having a collaborative model such as PLC with structured time also engaged in informal activities based on their own time and classroom needs.   Teachers in this study willingly made their own plans to meet out of their contract hours and worked toward building a collaborative stance to address their needs. They jointly explored ideas, developed instructional strategies and developed lesson plans. They also embraced the opportunity to observe each other and applied what they had learned in their own classrooms. These ideas were found in the formal collaborative models suggested in the literature review (Lewis et al., 2006; Slavit & Nelson, 2009).

Through collegial support via informal process, teachers created an environment that supported their constant informal learning. They provided their peers with access to knowledge, teaching strategies and needed materials. Principals in these two schools supported this environment by valuing teachers' own time, dedication and expertise. The next section will highlight some of the constraints of collaboration that emerged during interviews.

Constraints of Collaboration. The analysis of interview responses found that lack of built in structured time for the same grade level collaboration and differences in personalities were the two constraints of collaboration. The structured weekly Professional Learning Community (PLC) time in these two schools were designed for different purposes each week. First PLC of the month was designed for staff meeting, second for cross curriculum meeting discussing at risk students, third one was for math department meeting and one was left for the same grade level collaboration. Thus, teachers teaching the same grade level curriculum were provided with only one PLC per month and that is why these teachers spent most of their own time for collaboration.

Providing teachers of the same content and grade level with additional regular PLC time could provide teachers with a regular weekly time to collaborate. Furthermore, additional regular time built into the master schedule may help teachers who don't have strong relationships nourish their relationships and ultimately motivate them to collaborate more on their time.

Differences in personality emerged as another constraint of collaboration as teachers shared their perception on sharing strategies and visiting each other's rooms. Teachers stated that they would prefer to open up their classrooms to the peers they felt comfortable with. This constraint reinforced the important role of trust in the outcome of collaboration especially the benevolence and openness facets of trust. Leadership has a critical role in becoming sensitive to issues that could diminish trust in schools. They need to come up with strategies to help teachers to become more tolerant of each other's differences, become more respectful of each other and overcome personality issues. One way may be to continually remind teachers that the work they do is not about them rather it is about serving student's best interest. Principals in this study continually reminded teachers about the importance of setting aside individual differences and working toward accomplishing shared goals for students. Another strategy to help teachers resolve their differences may include having regular activities during staff meetings that could help teachers get to know each other better on a personal basis. Teachers in the these two cases noted their ability to overcome issues related to individual differences in working together for the benefit of all students. Teachers demonstrated their ability to overcome differences through respecting different approaches to teaching and focusing on reaching the end results of serving students' best interest.

Conclusions

From this study of mathematics teachers' collaboration and its supportive conditions in two instructive cases, several important conclusions can be drawn. First, this study confirmed other research on the importance of structural and cultural conditions independently if high performing cases of collaborations are to be established. The second conclusion is that teachers and administrators in high performing cases of collaboration hold high perceptions about collective efficacy, share a common goal of students' best interest, and reflect a culture of high expectation for student learning. The third conclusion is the critical role trust plays in the development of structural conditions leading to more collaboration, improved practice, increased classroom success, and enhanced collective efficacy. The fourth conclusion is that high performing collaboration leads to high teacher learning and ultimately teaching practice. The fifth conclusion, unique to this study, is the critical interactions of these conditions that are needed to establish and sustain high performing collaboration. Finally, this study concluded that teacher learning mostly occurs via informal collaboration based on teachers' own needs, willingness and time.

This study suggests that there is much more overlap and interaction between these supportive conditions than what has been suggested in previous studies. The findings indicate that we cannot think about these supportive conditions as separate structural and cultural approaches; instead, we have to think about these as interconnected approaches because they highly overlap. Thus, a significant finding of this study is the strong interconnection and interdependence between cultural and structural conditions as well as teaching practice. This finding not only supports the initial proposed model of a

combination of structural and cultural conditions as a predictor for high performing collaboration but, more importantly, it suggests a revised model that is much more interactive. The following section discusses the revised model.

       Interdependence: A New Theoretical Model. The initial proposed model that was based on the literature review is different from the revised model based on the findings. The initial models suggested, in order to have effective collaboration, a combination of both structural and cultural conditions are needed. However, after the study was completed, this model was revised and a new theoretical model emerged from the findings.

       As Figure 5 illustrates, the revised model (or Interdependence Model) includes one additional structural condition of physical proximity, and two additional cultural conditions of focus on students' best interest and culture of high expectation. The Interdependence Model shows that physical proximity is advantageous for the frequency of teachers' informal collaboration. The two additional cultural conditions of focus on students' best interest and culture of high expectation are illustrated as additional catalysts for the development of structural conditions and high performing collaboration.

       Unlike the initial model that included both individual and collective efficacy, the Interdependence Model reveals collective efficacy as the influential condition. Furthermore, this new theoretical model reflects intense interconnection and interdependence between the structural conditions, cultural conditions, and both cultural and structural conditions. This model also shows that although there is a reciprocal connection between the structural and cultural conditions, the cultural conditions lay the foundation for the development of structural conditions.

More importantly, as evidenced by participants' responses, the Interdependence Model presents that trust is the most critical predictor for the development of the structural conditions. With high levels of trust, teachers of the same grade level (collective participation) increase their willingness to spend more of their own time (duration), to share strategies and visit each other's rooms (active learning), and discuss shared curriculum (content). Thus, high levels of trust facilitate the development of structural conditions. The increased level of structural conditions in turn produces high performing collaboration leading to improvement in teaching practice. As a result of improved practice, teachers experience more classroom success leading to higher collective efficacy. Higher collective efficacy along with focus on students' best interest and culture of high expectation in turn increase teachers' willingness to work together and produce high performing collaboration. The more teachers collaborate, the more they focus on their daily goals, discuss curriculum and get involved with active learning which all result in spending more time. The more time they spend together, the more they trust each other and the cycle starts all over again.

Figure 5. Interdependence: A New Theoretical Model

This new model supports the previous studies in that willingness to collaborate and participate in productive teamwork depends on an individual's trust in others and perceived trustworthiness (Brown & Scott, Poole & Rodgers, 2004 & Daly, 2009). Hence, a significant finding of this study is not only the strong interconnections between cultural and structural conditions, but also cultural conditions— especially trust—as a critical predictor for high performing collaboration. This finding confirms the previous studies in that trust may foster an environment of improved teaching efficacy in which teachers improve their practice and thus experience more success in the classroom (Bryk & Schneider, 2002; Goddard, Hoy, & Hoy, 2004).

Thus, the Interdependence Model changes the theoretical view from a perspective

that focuses on the structural and cultural perspectives independently to a more complex web of interconnected and interdependent structural and cultural perspectives. Understanding these interactions may be useful for educational leaders as these cultural conditions may be leveraged to better develop and sustain effective collaboration in support of enhanced teaching and ultimately increased student achievement.

The findings of this study support efforts in connecting district leaders, principals and teacher leaders in order to stimulate and facilitate the development of cultural conditions in schools. An additional benefit from these findings is the opportunity to yield valuable information about which cultural condition provides the most supportive condition for the successful collaboration, trust. The likelihood of successful collaboration may be increased by an intentional effort at influencing the level of trust in support of enhanced teaching practice and ultimately student achievement. The following section will explain the implications of this study for district leaders, principals and teacher leaders.

Implications For District Leaders. Districts interested in collaboration as a strategy for teaching improvement should consider structural and cultural conditions as interactive and complementary components of high performing collaboration. Knowing that cultural conditions, especially a high level of trust and collective efficacy, lead to high performing collaboration helps district leaders to support their principals to sustain the collaboration process.

District leaders should closely examine principal leadership styles and provide the necessary skills and staff development, supporting principals in how to develop trust and collective efficacy to ensure greater support for teacher collaboration. They should also

support principals in providing teachers with additional structured time to collaborate.

Implication for Principals. The findings from this study suggest that investing in the creation of high trust environments has a host of positive effects for teacher collaboration and classroom success. One route through which principals may increase the potential of teacher collaboration is by stimulating the development of trust. Therefore, first, principals should look for strategies to strengthen relationships and promote a culture of trust in schools. The development and maintenance of trust—specifically Benevolence, Openness, Reliability and Competence—within and between teachers, support more effective collaboration with the potential to increase teaching practice and ultimately address student achievement gaps. As trust increases, teachers show more willingness to collaborate on their own time, become more comfortable with sharing their personal data and best practices and teacher learning increases. One strategy to develop trust could be the development of ongoing planned activities during staff meetings to help teachers get to know each other better on a personal basis. It is recommended that principals gain further knowledge on ways to increase trust.

Second, principals need to be mindful about possible personality differences between staff members and find strategies to help teachers become more accepting and tolerant of their differences. This may be accomplished through planned collaboration meetings during which teachers share with each other their strengths and concerns regarding their classrooms.

Third, principals should gain knowledge on how to increase collective efficacy in schools. One strategy to increase collective efficacy could be the acknowledgement of staff's past successes and ongoing recognition of teachers' strengths. Principals should

also focus on getting everyone on board with the school's shared goals of serving students' best interests and high expectations for student learning. Principals should work with teachers to develop vision statements that reflect and quantify "students' best interests" and the nature of a culture of high expectation. When the whole staff is involved in developing the shared vision, personal ownership of this vision is more likely as is collaboration to make that vision a reality. Furthermore, principals need to reexamine the structured work time that has been built into the master schedule for grade level collaboration and make the necessary adjustments according to teachers' feedback. For schools that are implementing Professional Learning Communities (PLCs) the challenge for the Principal is to ensure that each grade level has a regular and sufficient PLC time for same-curriculum collaboration.

Lastly, this study found that teachers with common prep used most of their prep time to make copies and had less opportunity to observe their peers teaching the same lesson. On the other hand, teachers who had different prep times were able to have an opportunity to visit their colleagues' classrooms and benefit from observing one another. Thus, from a leadership perspective, it might be beneficial to provide teachers of the same content and grade level with different prep time and provide more support for classroom visitations and teacher learning.

Implications for Teacher Leaders. The findings of this study provide teacher leaders with a better understanding of supportive and constraining conditions of the work they do as a team. The hope of this study is to increase teacher awareness in terms of supporting one another to build and maintain trusting relationships, as trust appears to be the most critical condition for effective collaboration. Furthermore, it is vital that teacher

leaders help other teachers set aside their individual differences, validate each others'

contribution as a team member, and work together to serve what is best for students.

When teachers accept and respect their differences and focus on the ultimate goal of

serving students' best interests, personality conflicts might diminish leading to stronger

collaboration. The following sections will highlight the implications for future research

followed by limitations of the study and commentary with conclusion.

Implications For Future Research. The results of this study and the new

theoretical model highlight several areas for further research. First, the identification of

trust as the most supportive condition in this study provides the need for more detailed

research investigating the influence of different facets of trust and ways to renew and

rebuild trust in educational contexts. The second implication for future research involves

the link between collective efficacy and trust. This link provides an opportunity to

understand the influence and the direction of the influence of these two constructs in new

ways that could hold promise for deeper theoretical understanding and practical

knowledge pertinent to strong collaboration.

Third, although this study did not investigate teacher collaboration and student

achievement directly, it is not unreasonable to speculate that the explanation for the

results of this study is that teacher collaboration fosters teacher learning that, in turn,

improves instruction leading to higher student achievement. Thus, collaboration is not

only good for teachers, it may quite possibility, by fostering teacher learning, also be

positively related to student achievement. A future study is needed to investigate the

relationship between teacher collaboration and student achievement directly.

A fourth area for further consideration is to study strategies to increase trust and

collective efficacy as part of the collaboration process. How can trust and collective efficacy be increased, especially during the beginning of school year? What trust and collective efficacy factors affect the sustainability of the collaboration process?

A fifth area to consider is exploring the relationship between individual efficacy and collaboration. While this study found strong correlations between all structural and cultural constructs through a variety of statistical tests and interview data, the relationship between individual efficacy and these constructs remained low. In what ways does individual efficacy influence collaboration? The field would benefit from studies using the Interdependence Model from a stratified randomized sample of all types of districts; sites including elementary, middle and high schools; grades and subject matters.

A final area worth exploring is teachers' perception of principal leadership quality in promoting a culture of trust. What practices and skills do site leaders need to ensure a high level of trust?

Limitations of the Study

Due to its exploratory nature, this study was only intended to identify structural and cultural conditions that exist in high performing cases of collaboration. Given the limited number of districts that participated, as well as the limited number of participating schools and time and resources available, one limitation of this study is its sample size. Because some grade level teams were relatively small, care must be taken in generalizing study findings to the larger population. Similarly, because the interview sample of four administrators was small, the findings from the four interviews should be seen as supplementary information from four administrators who were successful with

collaboration rather than information providing a definitive path towards success.

Additionally due to the lack of time and access to the collaboration meetings, I was not

able to perform observations and collect additional data for data triangulation. This study

was done based on teachers' own perception; therefore, the self-report aspect of the study

could be a limitation of the study. Finally we should be cautious about generalizing the

findings to other school settings because the study was performed in middle school

setting and middle schools are usually set up for more collaboration than other school

settings.

Commentary and Conclusions

The achievement gap in mathematics is real and has been consistently

documented for the last two decades. Despite great efforts by educators at all levels, very

little systematic progress has been made in closing the gap. This study suggests that high

performing teacher collaboration may increase teaching effectiveness and ultimately help

educators increase student learning and close the achievement gap. For high performing

collaboration, not only high levels of structural and cultural conditions will be needed,

but also attention needs to be given to developing high levels of trust as a predictor of all

other conditions. It is important to note that while the idea about the critical role of trust

came out of middle school setting, it could be applied to the other educational settings as

well.

This study has been invaluable to me, both as a PLC facilitator and future

educational leader. First, I take from this research a better understanding about the role

trust plays in the work we do in our schools. I have become more sensitive to issues that

could diminish the level of trust between teachers such as issues related to personality differences. Personalities that are reflective of controlling behavior and egos could discourage others from sharing their ideas and possibly result in distrust and disrespect. I believe this area could be addressed by developing group norms of behavior within the teams and by making every teacher equally involved with creating these behavior norms. When the entire team is involved with developing these norms, it would be easier to prevent issues related to unacceptable behaviors before they arise and teachers will be better equipped to deal with conflicts when they occur. Another implication of this study for me is to ensure every member of the team feels equally valued and is able to make a contribution or assume a leadership role. Feeling valued by peers may strengthen trust and increase efficacy leading to increased participation. Thus, it is important to find value in the work, skills and knowledge of our colleagues and acknowledge the strengths they have.

APPENDIX A: SURVEY INSTRUMENT

1. Please identify your gender
   Male-----------------Female-----------------Decline to state-------------
2. What subjects do you teach?
   ----
3. Please indicate the numbers of years teaching
   ----
4. Please identify the numbers of years full-time teacher in your current school
   I have worked at my current site for --------------------
5. Please identify he grade level you teach
   6th----------------7th --------------------8th ----------------------
6. Please check your highest degree earned
   a. Highest Degree: Bachelor's--------Master's---------Doctoral--------Other---------

Directions:
The following are statements about your school's mathematics collaboration.
Please indicate the extent to which you agree with each statement along a scale
from strongly disagree (1) to strongly agree (6). Your answers are confidential.

		1	2	3	4	5	6
1	I apply skills in my classroom that I learn during our collaboration						
2	Our collaboration helps me to use differentiated instruction in my classroom						
3	As a result of our collaboration, I use different forms of assessments						
4	My teaching performance has been enhanced by our collaborative activities.						

		1	2	3	4	5	6
5	I have made specific changes in my teaching as a result of our collaboration						
6	Our collaboration has helped me to become more effective teacher						
7	I have become committed to some new teaching strategies as a result of our collaboration.						
8	I learn practical instructional strategies during our collaborative activities.						
9	Our collaboration has a positive impact on my students' achievement						
10	I can note changes in my teaching performance because of our collaboration.						
11	Our collaboration involves planned activities with specific topics						
12	Our collaborative activities are connected and are followed up by the previous activities.						
13	Our collaborative activities are consistent with teachers' classrooms goals.						
14	Our collaborative activities support national, state and district standards.						

		1	2	3	4	5	6
15	The focus of our collaboration is on the deepening of teachers' knowledge of mathematics.						
16	The content of our collaboration has relevance to teachers' needs.						
17	Our collaborative activities are ongoing throughout the entire year.						
18	Our master schedule gives teachers at least an hour per week to collaborate.						
19	Our principal provides us with additional collaboration time if it is needed						
20	Our school provides teachers with extra time to visit each other's room.						
21	School provides teachers with time to collaborate by common planning time.						
22	School provides us with collaboration time by extra days built into our year.						
23	Teachers collaborate informally outside their contract hours						
24	During our collaboration, teachers share their instructional practices						

		1	2	3	4	5	6
25	During our collaboration, teachers share student work.						
26	Teachers develop lesson plans during our collaboration.						
27	Our collaboration allows teachers regular observations by peers and feedback.						
28	Our teacher leaders facilitate our meetings keeping the focus on content.						
29	Our collaboration involves the participation of teachers from the same grade level and same subject.						
30	Teachers in this school trust each other.						
31	Teachers in this school can rely on each other.						
32	Teachers in this school have faith in the integrity of their peers.						
33	Teachers feel safe to open their classrooms to other teachers.						
34	Teachers are willing to share information about their classroom with peers.						
35	Teachers here believe their colleagues are competent						
36	Teachers in the school are able to get through to the most difficult students.						
37	Teachers here are confident they will be able to motivate their students.						
38	Teachers in the school are skilled in various method of teaching math.						
39	Teachers here are well prepared to teach math.						
40	Teachers here have what it takes to get students to learn math.						
41	Teachers here truly believe every student can learn						

		1	2	3	4	5	6
42	When I really try, I can get through to most difficult or unmotivated students.						
43	If a student struggles with lesson, I would be able to assess the problem and use a different strategy to him the lesson.						
44	If a student did not remember the information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.						
45	The amount my students can learn math is related to my teaching						
46	I have enough training to deal with almost any learning problem.						
47	It is a teacher's obligation to see to it that every child makes academic growth.						

APPENDIX B: INTERVIEW PROTOCOL

Interview Questions for Teachers

1. *How would you describe the nature of your math collaboration?*

Follow up questions might include:

What types of collaborative activities are you involved with?

Do you collectively inquire issues related to teaching math?

Do you work with university partners?

Do you develop lesson plans regularly?

Do you decide on a topic with teaching and research on the topic?

2. How *do you feel about the impact of your collaboration on your teaching math?*

Follow up question:

Do you think your instructional practices; assessment and ability to reach difficult students have changed as a result of your collaboration?

In what ways your teaching has improved as a result of your collaboration?

3. *What structural factors do you think contribute to the success of your collaboration?*

Follow up questions:

How much time do you spend per week collaborating?

Does your principal provide you with extra time? Or you spend your own time?

How important the content focus is and why?

Do all the teachers from your grade level and subject participate in your Meetings?

Do you visit each other's room and how frequently?

Do you have time to provide feedback to your peers?

Do you share your students' work?

4. *What role does trust play in the effectiveness of your collaboration?*

This question is not complete unless we understand:

What makes them to trust their peers?

5. *How do you feel about the capability and skills of teachers in your team to teach all students?*

6. *How do you feel about your own skills and capability to reach difficult students?*

7. *Does your team's skills and competency influence how you feel about your own capability? How?*

APPENDIX C: INTERVIEW PROTOCOL

Interview Questions for Principals

1. How *do you feel about the impact of your support on the collaboration of your math teachers?*

Follow up question:

   In what ways the success of your teachers' collaboration has improved as a result of your support?

2. What structural factors do you think contribute to the success of your teachers' collaboration?

Follow up questions:

   How much time do your teachers spend per week collaborating?

   Do you provide your teachers with extra time? Or do they spend their own time?

   How important the content focus is and why?

   Do all the teachers from the same grade level and subject participate in? their collaborative meetings?

   Do your teachers visit each other's room and how frequently?

   Do you provide teachers with e time to give each other feedback?

3. What role does trust play in the effectiveness of your teachers' collaboration?

   This question is not complete unless we understand:

   What makes teachers to trust their principal and peers?

4. How do you feel about the capability and skills of your math teachers to teach all students?

5. Does your school's competency influence how individual teachers feel about their own capability? How?

APPENDIX D: INTERVIEW CONSENT LETTER

Consent Letter for Interview Participants
Farzin Dunning
farzindunning@hotmail.com

Dear Teachers and Principals,

You are invited to take part in a research study regarding the examination of structural and cultural conditions of effective collaboration in mathematics.

What the study is about: This study is designed to gain a better understanding of the structural and cultural conditions of reform-type professional development (PD) that supports effective collaboration among middle-school mathematics teachers. This unique study will investigate the impact of both structural and cultural factors of reform PD and their relationship in a new way to better understand effective collaboration in mathematics.

Number of participants: Fourteen math teachers grades 6th, 7th, 8th and six administrators will be invited to be interviewed.

What you will be asked to do: As a participant, you will be asked to participate in an interview. You will be asked to respond to 10 interview questions posed by the researcher. Interviews will take about an hour, and they will be audio recorded for accuracy. There are no negative consequences if you do not agree to participate. You may decline to answer any question or change your answer. You may also withdraw from the interview or group at any time or request that your portion of the audio recording be erased. There are no negative consequences if you do not agree to participate.

The study will also include one observation during your collaboration meeting. If all teachers in the meetings agree to be observed, the collaborative activities of teachers at each site will be observed once and field notes will be taken. During the observation, the researcher will only make observation and take notes on the way participants are interacting with each other, planning lessons and analyzing student data. This part of the study is important because it may provide additional support for the findings from surveys and interviews. Data from the observations will be coded based on extant literature regarding structural and cultural factors impacting the outcomes of collaboration. This information will help the researcher to have a better understanding of the interaction between collaboration, structural and cultural conditions in highly effective cases. There are no negative consequences if you do not agree to be observed. This part of the study will be done only if all participants agree to be observed.

Risks and Benefits: There will be no risk of loss of confidentiality associated with the research study. All consent forms will be separated from the data collected and will be kept in a lock box therefore disconnecting data from the participants' names. All study materials will be maintained in a secure manner and data will be anonymized. Study ID numbers will be assigned to teachers and principals. All digital data will be kept in researcher's secured computer in password-protected files. All the hard copies will be kept in a lock-box that only researcher will have access.

Stress, discomfort, fatigue and boredom could be some of the risks associated with being interviewed. You can stop the interview and withdraw from the study at any time without consequences of any kind. Because this is an investigational study, there may be some unknown risks that are currently unforeseeable.

There might or might not be any direct benefit to participants. However, this study might benefit schools and districts because it could provide teachers and school leaders with important information pertaining to effective collaboration. School leaders could use the information to support the conditions that could make math teachers' collaboration more successful. The school leaders and teachers will be informed about the findings of this study after the analysis and conclusions of the research are completed.

Taking part is voluntary: Taking part in this study is completely voluntary. If you choose to be in the study, you can withdraw at any time without consequences of any kind. You may choose to leave for a particular question, or simply not contribute to the discussion for a particular question. Your choice to participate or not will have no bearing on your employment status and data will not be shared with a supervisor. Alternative to participate is not to participate.

There is no compensation for your participation in this study, and the only benefit is the chance to provide your perception of effective math collaboration that could result in improved teaching and student learning in mathematics.

Your answers will be confidential: Research records will be kept confidential. All consent forms will be separated from the data collected and will be kept in a locked file box therefore disconnecting data from the participants' names. Your names will not be included in reports. Any potentially identifying information will be removed and every effort will be made to protect confidentiality.

Data will be kept on recorders and then destroyed once the discussions have been fully transcribed. Transcriptions of the discussion will be kept on a secured personal computer to which only the researcher has access. The interview data will initially be recorded using an audio recorder. The researcher will keep the interview data in a locked file box until they are fully transcribed. The recording will be used only until fully transcribed and will then be destroyed so the voices of participants will no longer be able to be used to identify the individual. Once interviews have been transcribed, the audio records will be

deleted and destroyed. The transcribed data will be saved on a private computer to which only the researcher has access. Hard copies of transcriptions will be held in a locked file box separate from the individual consent forms. Any report of this research that is made available to the public will not include your name or any other individual information by which you could be identified.

If you have any questions about the research: Please contact me at (858) 774-6512 or my dissertation committee chairperson, Dr. Alan Daly at (858) 822-6472. If you have questions about your rights as a research subject, or wish to report a research-related problem, please contact the Human Research Protections Program at (858) 657-5100. You have received a copy of this consent document to keep.

Sincerely,

Farzin Dunning
UCSD
farzindunning@hotmail.com

Statement of Consent: Ms. Dunning has explained this study to you and answered your questions. You have read the above information and have received answers to any questions. You consent to take part in the research study of the structural and cultural conditions of effective math collaboration in middle school.

If you agree to participate in the research, please sign here:

Your Signature:_____   Date:_____

Your Name (please print): _____

APPENDIX E: AUDIO RECORDING RELEASE CONSENT FORM

**UNIVERSITY OF CALIFORNIA, SAN DIEGO
AUDIO RECORDING RELEASE CONSENT FORM**

As part of this project, an audio recording will be made of you during your participation in this research project. Please indicate below the uses of these audio recordings to which you are willing to consent. This is completely voluntary and up to you. In any use of the audio recording, your name will not be identified. You may request to stop the recording at any time or to erase any portion of your recording.

1. The audio recording can be studied by the research team for use in the research project.

_____
Initials

You have the right to request that the recording be stopped or erased in full or in part at any time.

You have read the above description and give your consent for the use of audio recording as indicated above.

_____
Signature   Date   Witness

Consent Letter for Survey Participants

Farzin Dunning
farzindunning@hotmail.com

Dear Teachers and Principals,

You are invited to take part in a research study regarding the examination of structural and cultural conditions of effective collaboration in mathematics.

What the study is about: This study is designed to gain a better understanding of the structural and cultural conditions of Professional Development (PD) that supports effective collaboration among middle-school mathematics teachers. This unique study will investigate the impact of both structural and cultural factors of PD and their relationship in a new way to better understand effective collaboration in mathematics.

What you will be asked to do: As a participant, you will be asked to participate in a 10-20 minute survey with 50 questions. All teachers and principals of middle schools at your district will be given secure online surveys using randomly assigned study ID numbers rather than your name. There are no negative consequences if you do not agree to participate.

Risks and Benefits: There will be no risk of loss of confidentiality associated with the research study. All consent forms will be separated from the data collected and will be kept in a lock box therefore disconnecting data from the participants' names. All study materials will be maintained in a secure manner and data will be anonymized. Study ID numbers will be assigned to teachers and principals. All digital data will be kept in researcher's secured computer in password-protected files.   All the hard copies will be kept in a lock-box that only researcher will have access.

Surveys will be submitted using an assigned ID number to keep the confidentiality. Stress, discomfort, fatigue and boredom could be some of the risks associated with taking the surveys. You can stop the survey and withdraw from the study at any time without consequences of any kind. Because this is an investigational study, there may be some unknown risks that are currently unforeseeable.

There might or might not be any direct benefit to participants. However, this study might benefit schools because it could provide teachers and school leaders with important information pertaining to effective collaboration.   School leaders could use the information to support the conditions that could make math teachers' collaboration more successful. The school leaders and teachers will be informed about the findings of this study after the analysis and conclusions of the research are completed.

Taking part is voluntary: Taking part in this study is completely voluntary. If you choose to be in the study, you can withdraw at any time without consequences of any kind. You may choose to leave for a particular question, or simply not contribute to the discussion for a particular question.

Your choice to participate or not will have no bearing on your employment status and data will not be shared with a supervisor.

There is no compensation for your participation in this study, and the only benefit is the chance to provide your perception of effective math collaboration that could result in improved teaching and student learning in mathematics.

Your answers will be confidential: All consent forms will be separated from the data collected and will be kept in a lock box therefore disconnecting data from the participants' names. Research records will be kept confidential. Your names will not be included in reports. Any potentially identifying information will be removed and every effort will be made to protect confidentiality. Any report of this research that is made available to the public will not include your name or any other individual information by which you could be identified.

If you have any questions about the research: Please contact me at (858) 774-6512 or my dissertation committee chairperson, Dr. Alan Daly at (858) 822-6472 If you have questions about your rights as a research subject, or wish to report a research-related problem, please contact the Human Research Protections Program at (858) 657-5100. You have received a copy of this consent document to keep.

Sincerely,

Farzin Dunning
UCSD
farzindunning@hotmail.com

Statement of Consent: Ms. Dunning has explained this study to me and answered my questions. I have read the above information and have received answers to any questions. I consent to take part in the research study of the structural and cultural conditions of effective math collaboration in middle school.

If you agree to participate in the research, please sign here:

Your Signature:_____   Date:_____

Your Name (please print): _____

Phase One

Quantitative Data Collection surveys

Quantitative Data Analysis Descriptive Statistics, Correlation

Phase Two

Qualitative Participant Selection Two Instructive Cases

Qualitative Data Collection Interviews

Qualitative Data Analysis, Organizing, Coding

Interpretation of Qualitative Results

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