An Exploratory Study about the Influence of Distributed Leadership and Specialized Content Knowledge on Elementary Teacher Conversations about Mathematics Instruction

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Authorization to Submit Dissertation

The dissertation of Jacquelyn Ismail, submitted for the degree of Doctor of Philosophy with a major in Educational Leadership and titled "An Exploratory Study about the Influence of Distributed Leadership and Specialized Content Knowledge on Elementary Teacher Conversations about Mathematics Instruction" has been approved in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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Abstract

As many schools in the United States transition to the Common Core State Standards there is a greater need for teachers to have a depth of knowledge in Mathematics that allows them to address student thinking and provide important conceptual instruction in elementary school. Teachers often gain this knowledge through professional development, and it is beneficial if they are in a school environment that allows them to share this knowledge with colleagues through conversations occurring during collaboration. For these reasons, this study investigated the influence of: (1) elementary teacher specialized knowledge in mathematics gained through professional development, and (2) principal distributed leadership on the frequency of conversations about mathematics. Quantitative methodology was utilized with data collected through an online survey from 88 elementary classroom teachers. Data were analyzed using a 2x2 factorial ANOVA to determine the potential influence a teacher with specialized knowledge and/or the influence of a principal with a distributive leadership perspective on teacher conversations in mathematics. Results from this study indicate a significant interaction between the presence of a teacher with increased specialized content knowledge and administrator expectations for distributed leadership.

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Dedication

My dissertation is dedicated to my husband, Fahd Ismail. This would have never happened without your unwavering support. Thank you for enduring lonely weekends and evenings while I was behind a computer. Thank you for reminding me I could do this when I was unsure if I could. Thank you for allowing me to share my passion with you. Thank you for celebrating every milestone, both large and small, as well as every moment in between. You are my rock, and I will be forever grateful.

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Chapter One: Introduction

The United States has made a radical shift in recent years with the types of careers available to students and the level of education required to enter these careers. Few career paths provide career-long security, so workers are required to acquire new skills throughout their careers. For workers to be able to do this, it is helpful if their education prepares them for this lifelong journey of learning by equipping them with necessary skills to obtain and make sense of new knowledge (Conley, 2014). When a country has a more educated workforce, it can lead to better long-term economical growth dependent on the knowledge and skills of its workers (Schmidt & Burroughs, 2013).

The United States has also seen a shift away from the likelihood of workers staying in one location for their entire career. In past years, graduating students were able to find good long-term employment in the same community in which they received their education; therefore the standards for education needed only to be consistent within smaller local areas (Conley, 2014). Advances in technology have allowed the workforce in the United States to become more mobile, and the mobility of current and future generations will require increased consistency in educational standards across states. In the past, various sets of grade level standards and proficiency levels have existed from state to state in the United States, leading to different educational opportunities and expectations for students learning in different locations (Schmidt & Burroughs, 2013).

In addition to changes in the workforce and variance in standards, many students who go on to college are not fully prepared for their next steps. These unprepared students are required to take remedial courses in college before enrolling in classes that could count towards their chosen degree. This lack of preparedness costs both the students needing to take additional courses, and the colleges and universities having to supply the courses, a significant amount of money each year (Conley, 2014).

As a response to the need for students to be better prepared for college and future careers, and the need for consistency in standards and expectations among states, a group of state governors and educational commissioners met in 2009 to begin the development of the Common Core State Standards (CCSS) (Conley, 2014). The resulting document (CCSS) includes standards for English and language arts and mathematics for students in kindergarten through twelfth grade (Common Core State Standards Initiative, 2010). This study looked at one of the implications of the content and practice standards within the Common Core State Standards for Mathematics (CCSS-M) (Common Core State Standards Initiative, 2010).

Prior to implementation of the CCSS in the United States, the average expectation for performance in mathematics was two grade levels behind that of other countries, many of which have been outperforming the United States on international assessments (Schmidt & Burroughs, 2013). This discrepancy affects what students have the opportunity to learn, which creates a lack of equitable access among students internationally (Schmidt & Burroughs, 2013). The CCSS-M are much more consistent with the internationally developed A+ standards, which allows the United States to begin to close the gap in what students are exposed to during their education (Schmidt & Houang, 2012).

The United States also has seen a high variability in individual state mathematics standards along with a wide range in proficiency cut scores for state testing. Schmidt and Houang (2012) performed an analysis of state standards in mathematics and the relationship to the state's average scores on the National Assessment of Educational Progress (NAEP) prior to any state's transition to the CCSS. They began their analysis by looking at how closely each state's standards aligned with the CCSS, and found varying degrees of alignment. When comparing the alignment to NAEP scores, they found a positive relationship between alignment to the CCSS (prior to adoption of the CCSS) and NAEP scores. Schmidt and Houang (2012) also looked at cut scores required for proficiency with the standards within each state, and found that states with high alignment to the CCSS and with higher proficiency cut scores had an even stronger positive relationship to NAEP scores. Their findings indicate potential beneficial support through student achievement gains with alignment to CCSS.

Contextual Information

This study focuses on elementary math teachers in three school districts in Idaho and the knowledge these teachers need to teach mathematics in elementary school. All teachers in this study are working to align their instruction to meet the depth and rigor of CCSS-M. In an effort to better prepare mathematics teachers, all mathematics teachers in the state of Idaho are required to take a course entitled Mathematical Thinking for Instruction (MTI) as part of their recertification requirement. The course was developed as part of the Idaho Initiative for Developing Mathematical Thinking (Idaho Math Initiative, n.d.). The MTI course was designed to provide Idaho teachers and administrators with knowledge and teaching practices needed to effectively support student learning. The knowledge gained in the course allows teachers and administrators to better understand mathematics, how students learn mathematics, and how to best facilitate student learning in the classroom.

After taking the MTI course some teachers attend follow-up workshops and trainings to gain additional knowledge, but given the large number of teachers in the vicinity and the limited number of instructors, the professional development is often provided on a large scale to assist as many educators as possible. This creates a potential for a spillover effect in which those attending the professional development are asked to share knowledge with colleagues, therefore spreading the knowledge to others who did not attend the professional development session. Spillover effects from professional development have been shown to help elements of reform reach individual teachers (Borko, Elliott, & Uchiyama, 2002). The spillover requires teachers to take on a leadership role as they share the knowledge they gain in the professional development. Many elementary teachers find the opportunity to share this knowledge through conversations during their grade-level collaboration meetings. This is time set aside by the local school districts for teachers to meet and discuss various content and student thinking happening in their classrooms.

Looking at the intent and focus of the standards can help in clarifying how the CCSS-M may help prepare students for college and future careers. The CCSS-M has a connection to what is known about how students learn mathematics, which is addressed in the placement and language of the standards at each grade level (Common Core State Standards Initiative, 2012). The standards are built on the idea that to truly understand mathematics, students need both procedural skills and conceptual understanding, both of which are addressed throughout the standards. Students must also have opportunities for shared experiences in mathematics such as being asked to engage in problem solving, reasoning and communication. These necessary experiences are also addressed in the standards through the practice standards, which indicate performances in practice for all K-12 mathematics classrooms (Common Core State Standards Initiative, 2010).

The shifts in what students are expected to understand and be able to do in mathematics will require teachers to adjust their expectations of students and their teaching to better focus on the deeper, more rigorous standards (Conley, 2014). Teachers must understand that how the content a student is ready to learn at any grade level is dependent on previous knowledge and experiences, so teachers must be able to adapt their instruction to students' current level of understanding in an effort to reach grade level standards (Common Core State Standards Initiative, 2010). Pressure is placed on teachers, as they are one of the keys to the success of student performance in relation to the standards. Schmidt and Burroughs (2013) stated, "at the end of the day, successful implementation of the CCSS-M requires a focus on changes in instruction" (p. 9). Changed in instruction can be problematic for teachers when they do not feel prepared to teach the CCSS-M due to a lack of knowledge in mathematics.

Importance of Developing Teacher Leaders

With over a million elementary teachers in the United States, raising teachers' level of mathematical understanding through professional development is a daunting task. One way to address this professional development scaling issue is to have teacher leaders in mathematics in elementary schools (Wu, 2009; Reys & Fennell, 2003). Professional development is one way to help teacher leaders gain the necessary knowledge for teaching mathematics. Effective professional development should include direct connections to student thinking to help elementary teachers increase their knowledge, and should take place over an extended period of time (Sun et al., 2013).

Importance of Leadership Support

Ideally, teacher leaders with specialized knowledge in mathematics return to schools where they are able to be a part of the leadership process and are asked to share their knowledge with their peers to help facilitate the spread of knowledge within a school. After participating in professional development, teachers can share and extend their knowledge through collaboration with their peers, which can help influence changes in instruction (Nickerson & Moriarty, 2005). Effective conversations during collaboration should include a focus on student thinking and important mathematical ideas, and this can be easier when someone in the group has a deeper level of knowledge (Wood, 2007). Teachers with increased knowledge in a particular content area can often emerge as informal leaders within the group as they work to help with questions arising from other teachers' classrooms and work to help their team better understand student thinking in mathematics (York-Barr & Duke, 2004).

An environment for enhanced teacher learning and collaboration for change can be established by an elementary school principal through distributed leadership. In a distributed leadership model, a principal recognizes the need for formal leaders, informal leaders, and followers to take a role in the leadership process. The recognition of various leadership roles allows for the transfer of knowledge among individuals as they work towards a common goal (Spillane, Halverson, & Diamond, 2004). Principals are tasked with the role of creating an environment to facilitate change while also supporting the activities teachers are engaged in as they work towards improvement. These activities can range from individual teachers gaining knowledge about how students learn mathematics to his/her empowerment to share that knowledge with his/her peers (Spillane & Kim, 2012).

Principal leadership can encourage collaboration meetings as a priority where teachers share their knowledge and become informal leaders by sharing their knowledge (Dumay, Boonen, Tinneke, & Dumme, 2013). Principals can set the tone and expectations for collaboration in their building along with providing a sense of shared leadership where teachers feel empowered to take on informal leadership roles such as providing instructional support to their peers (Supovitz, Sirinides, & May, 2009). The principal must support this collaboration and be involved in the conversations teacher are having as they work to improve their instruction in mathematics (Goddard, Goddard, Kim, & Miller, 2015).

Conversations occurring during collaboration meetings can be the setting for teacher leaders with greater knowledge in teaching mathematics aligned to the rigorous content in the CCSS to share their knowledge with peers. Principal support through a distributed leadership model can help foster an environment for these productive conversations to take place. Therefore, the purpose of the study will be to look at the potential effects of principal distributed leadership and elementary teachers with increased knowledge for teaching mathematics on the frequency of conversations about student thinking and instruction in mathematics during teacher collaborations.

Statement of Problem

As many states in the United States transition to the CCSS, there is a greater need for teachers to have a depth of knowledge in mathematics. Rigorous content and practice standards require students to be able to solve problems and communicate about mathematics with both procedural and conceptual understanding (Sun, Penuel, Frank, Gallagher, & Youngs, 2013). Many teachers lack the specialized and pedagogical content knowledge needed to teach mathematics conceptually and with a depth of understanding. Most teachers are a product of a system that did not require conceptual knowledge, so they are in turn lacking the ability to help students gain this knowledge (Ball et al., 2001). Lack of knowledge can lead to an inability to make correct pedagogical decisions around instruction and to guide student thinking (Ball et al., 2001). To help students gain this knowledge and to better understand the content and student thinking in mathematics, teachers need to have specialized content knowledge in mathematics. However, to address the situational problem solving and communication aspects called for in the standards, teachers must also possess sufficient knowledge about social learning theories (Ball, Lubienski, & Mewborn, 2001; Nickerson & Moriarty, 2005).

Many elementary schools are still using a one-room schoolhouse model from over a hundred years ago in which one teacher covers all subjects with one group of students throughout the course of the school day. Fuchang (2011) discussed how many elementary teacher preparation programs focus heavily on methods courses and have few content courses, so future teachers are prepared for teaching positions derived from this one-room schoolhouse model. The lack of content courses creates a systemic problem in which teachers are trained as generalists and know a little about each subject rather than having a depth of knowledge in any one content area (Wu, 2009). Without the depth of knowledge, teachers are unable to teach mathematics for conceptual understanding and make necessary connections for students to help guide student thinking and learning (Ball et al., 2001; Silverman & Thompson, 2008).

Nickerson and Moriarty (2005) described the need to recognize that teachers are being asked to help students engage in learning communities in the classroom, so in turn they need a chance to engage themselves through collaboration with colleagues so they can better understand what they are asking students to do in the classroom. Many teachers are the product of an educational system that focused instruction in a teacher-centered manner, and this training did not provide teachers with the necessary knowledge and skills to create a collaborative environment for students in today's classrooms. Therefore, opportunities must be provided to help teachers gain knowledge about engaging students in collaborative discussion (Nickerson & Moriarty, 2005). Chapman (2011) discussed how engaging teachers in professional development focused on gaining knowledge in inquiry-based teaching can help them shift from the teacher-centered practices present in many traditional mathematics classrooms.

Purpose of the Study

The purpose of this study was to look at the frequency of conversations among elementary level teaching teams related to the literature on teaching mathematics with the presence of a teacher who has attained specialized knowledge in mathematics along with a principal demonstrating high levels of distributed leadership. In order to make this comparison, it was necessary to determine a group of teachers who would have gained a level of specialized knowledge for teaching elementary mathematics. All teachers in the state of Idaho are required to take the MTI course as a requirement for recertification. The MTI course was built from the Developing Mathematical Thinking framework, which encompasses ideas of social learning theories and provides opportunities for teachers to develop their specialized content knowledge (Brendefur, Carney, Strother, & Hughes, 2011). For this reason, the researcher chose to study a program built from the same research base as the MTI course, that expands the knowledge of teachers in mathematics beyond that provided in the MTI course, and allowing teachers to gain specialized knowledge for teaching mathematics.

The researcher chose to study teachers who participated in a K-8 mathematics graduate certificate program in teacher education. To provide confidentiality, the pseudonym

MGC is used to describe the program and teachers who participated in the program. This graduate-level endorsement program offered at a local university defines a level of specialized knowledge in teaching mathematics necessary to be considered a teacher leader. The content focus and instructional method used throughout all courses in the program are aligned to the types of conversations about student thinking and instruction required to address the depth and rigor of the CCSS. The graduate-level endorsement program utilizes the Developing Mathematical Thinking Framework. This framework includes research from cognitive and social learning theories and the idea that students should be engaged in learning mathematics, and knowledge must be built from their own experiences in problem solving and engagement in activities (Gravemeijer & van Galen, 2003; Hiebert, 1997; Brendefur et al., 2011).

The graduate-level program consists of seven courses at the graduate level totaling 21 credits. All of the courses provide opportunities for teachers to engage in learning the mathematical content with a focus on how students learn mathematics. The specialized knowledge gained by taking these courses can help teachers to be seen as an informal leader within their school. To help support the leadership component and to push further for those who are seeking a more formal leadership role, one course in the program has a specific focus on teacher leadership in mathematics. All teachers in the study have completed at least six of the seven courses in the graduate program as either a graduate certificate or as part of a Master’s degree in Curriculum and Instruction.

Research Design

The study utilized quantitative methodology with data collected from 88 participants via online survey. The purpose of the study was to examine the potential influence of elementary teacher mathematical knowledge for teaching and principal distributed leadership on the frequency of conversations about student thinking and instruction in mathematics. The dependent variable in the study was the frequency of teacher conversation, and the independent variables were the presence or absence of a MGC teacher (increased knowledge) and the level of principal distributed leadership (high and low). The level of principal distributed leadership was determined by the survey and used to create groups. The analysis provided information about the potential influence of teacher knowledge and distributed leadership as separate factors and the potential interaction between both factors.

Research Questions

This study addressed the following questions:

1. Does the presence of a MGC teacher with an increased level of specialized content knowledge influence the frequency of conversation about student thinking and instruction in mathematics?
2. Does the level of principal's distributed leadership at the building level influence the frequency of conversations about student thinking and instruction in mathematics?
3. Does the presence of a MGC teacher with an increased level of specialized content knowledge and the presence of principal distributed leadership have additional influence on the frequency of conversations about student thinking and instruction in mathematics than one factor has on its own? In other words, does the interaction between these two variables have additional influence on the frequency of the desired conversations?

Hypotheses

Ho_1 – The presence of a MGC teacher makes does not influence in the frequency of conversation about student thinking and instruction in mathematics.

Ho_2 – The principal distributed leadership present at the building level does not influence the frequency of conversation about student thinking and instruction in mathematics.

Ho_3 – The presence of a MGC teacher and the presence of principal distributed leadership does not have an additional influence on the frequency of conversations about student thinking and instruction in mathematics than one factor has on its own.

Significance of the Study

The study has several areas of potential significance including a contribution to the current literature and providing information for the involved university and school districts. If a link can be made between knowledge gained through professional development and the frequency of conversations in collaboration, it would also provide support for implementing the framework used in professional development on a larger scale by including more teachers. The K-12 school leaders would be able to gain information about the effectiveness of the professional development, which could help them make future decisions about how to invest professional development funds. Findings from this research may also provide a framework for university faculty and administrators who work to provide programs of professional development.

This study also has potential to provide information about the importance of principal leadership and its impacts on conversations occurring during collaboration within a school. This information would be beneficial for school districts as they determine ways to better prepare, support and select elementary principals. Many school districts have also set aside time each week for teachers to collaborate, and knowledge about the influence the principal can have on the frequency of conversations related to important mathematical ideas in collaboration would help district administration set expectations for principals regarding collaboration time. The results of the study may also be useful for elementary principals to assist in reflecting on the practice of distributed leadership, and their support of teachers as they work towards reforming their mathematics instruction.

The distributed leadership perspective utilized in this study is aligned with standard in the second domain of the Idaho Foundation Standards for School Administrators: Collaborative Leadership (Idaho State Department of Education, 2014). This domain within the standards focuses on the administrator sharing leadership within the building to promote professional growth among teachers. Encouraging teachers to continually improve within the profession would include teachers taking time to research and learn about best practices, and administrators using teachers with increased knowledge to help facilitate growth among their peers (Idaho State Department of Education, 2014). Given the strong connection between this study and the collaborative leadership standards within the Idaho Foundation Standards for School Administrators, the results of this study will be able to provide administrators and administrator programs with a potential link to the importance of this domain within the standards.

A final, and important potential significance of the proposed study would be a contribution to the literature on the influence of elementary teacher knowledge and principal distributed leadership on the frequency of conversations related to mathematics instruction. If the study is able to show a larger influence on frequency of conversations in collaboration when both teacher knowledge for teaching mathematics and principal distributed leadership are present, then it would support the proposed model for collaboration. By demonstrating a greater influence when both factors are present, the study would demonstrate the importance of simultaneously focusing on both leadership and knowledge as teachers move towards reforming mathematics instruction in elementary schools.

Definition of Terms

Collaboration: For the purpose of this study, collaboration is defined as a way for teachers to focus on student thinking and learning through formal or informal discussions (West, 2008).

Distributed Leadership: A leadership perspective focused on the interaction of leaders, followers, and the situation. This includes the activities and interactions among all three factors and assumes that leadership expertise should be distributed among the group rather than held by an individual person (Spillane et al., 2004).

Factorial Design: A study design that allows for the researcher to look at levels within two or more factors (Privitera, 2015). In this study, factorial design will allow for the analysis of the interaction between the presence or absence of MGC teachers and the high or low level of principal distributed leadership.

Mathematical Knowledge for Teaching (MKT): The knowledge required of teachers to teach mathematics. This knowledge includes everything a teacher must know and do to foster student thinking and learning in mathematics (Ball, Thames, & Phelps, 2008).

Teacher Leader: For this study, a teacher leader is defined as a classroom teacher in an informal leadership position focused on instruction. Neumerski (2012) discusses the need for a person in this role to exhibit behaviors such as collaborating and building trust among colleagues in an effort to improve instruction.

Two-way ANOVA: A statistical procedure used to measure the variance in groups created by a factorial design (Privitera, 2015)

Specialized Content Knowledge (SCK): Includes deep knowledge of mathematics content unique to teaching including the ability to evaluate student thinking in mathematics (Shulman, 1986, Ball et al., 2001).

Teaching team: For this study, a teaching team is defined as a group of teachers who all teach the same grade level in the same school and meet together for planning and collaboration.

Assumptions

1. The teachers in the MGC program have gained knowledge for teaching mathematics and increased their understanding of student thinking in mathematics through the course of their study in the program.
2. High levels of distributed leadership as determined by the scales used in the survey will accurately measure principal distributed leadership through questions related to principal involvement and expectations for collaboration.
3. The items included in the survey instrument that will be used to demonstrate frequency of mathematics conversations accurately portray and measure structural ideas and student thinking in mathematics.
4. Teachers' responses to the survey are accurate and reflect the actual frequency of conversations.

Limitations

External validity was difficult to control due to the type of sampling used in the study and the specific definition of teacher knowledge in mathematics. However, this was an exploratory study, so the intent was not to be able to generalize the findings, but rather to determine whether there is a connection between the presence of a teacher with knowledge for teaching mathematics and/or the principal distributed leadership and the frequency of conversations occurring during collaboration. General ideas about the potential influence of teacher knowledge and principal distributed leadership on collaboration could be applied to other situations, but increased knowledge for teaching mathematics may be defined in various ways depending on the focus of future studies.

When using an online survey to collect data, the study was also open to teachers' interpretation of survey questions in their response. While each group of survey items has shown a high level of internal reliability, there was still the possibility of teachers interpreting the questions or their actions associated with those questions differently, which could therefore influence the results. Along with interpretation of items, it was also difficult to control for external pressures teachers may feel to respond to the survey items in a particular manner. The intent of the survey was communicated to participants and school/district administration, but external pressures of expectations may be present that the researcher was unaware of which could create bias in the results.

A comparison group was used to help address internal validity, but it was difficult to control for other causes in potential differences or similarities between groups. Questions were all related to knowledge for teaching mathematics created through professional development and principal distributed leadership, but possibilities still existed for alternate explanations for frequency of conversations occurring during teacher collaboration.

Delimitations

Self-report data were used in this study, which is dependent on teacher perceptions of their own frequency of conversations related to mathematical structure and student thinking. This created a dependence on teachers' accurate perceptions of their frequency of conversations and particular elements of the principal distributed leadership within their school. While this may have presented a challenge, studies have also shown the potential accuracy in self-report data in specific situations related to this study. For example, Koziol and Burns (1986) used self-report survey data to measure teacher classroom practices and found that a focus on one particular idea within a content area along with focusing questions on one specific time period can produce more accurate self-report data. When looking at reporting measures of principal leadership, Camburn, Huff, Goldring, and May (2010) found that survey data aligned with questions related to principal instructional leadership was more consistent than other areas of leadership. Instructional leadership in this study included activities such as principals making classroom visits and supporting their teachers' professional growth (Camburn et al., 2010). All of these activities are included in the roles an elementary principal would play when utilizing a distributed leadership framework.

The study only collected data from elementary teachers in three school districts who have completed a minimum of six courses in the MGC program and the teachers on their grade level teaching team. This sample was chosen to determine the potential influence of a particular program (MGC) on elementary teachers. The sample was limited to elementary teachers to help control for other potential influences secondary mathematics teachers would introduce to the sample such as a focus on teaching only one subject or teaching multiple grade levels.

Expected Outcomes

The second chapter provides information about the potential influence of teacher knowledge of teaching mathematics and principal distributed leadership on conversations occurring during teacher collaboration meetings. Since a link has been made between teacher knowledge and conversations occurring during collaboration and principal distributed leadership and conversations occurring during collaboration, the researcher looked to see if either one is shown to have an influence on the frequency of conversations about student thinking and instruction in mathematics. The researcher also hoped to find whether or not the presence of both knowledge and principal distributed leadership show a larger influence on the frequency of conversations than either of the factors show on their own. The literature review has provided evidence to support a connection between knowledge and collaboration and principal distributed leadership and collaboration. Therefore, both factors were expected to have an impact on frequency of conversations about student thinking in mathematics in collaboration meetings. Further, it was expected that a combination of influence from both knowledge and principal distributed leadership would have a larger impact on collaboration than either one on its own.

Summary

Chapter one provides an overview of the study along with contextual information for the professional development used to operationalize elementary teacher knowledge for teaching mathematics. Previous studies have shown teacher knowledge and principal distributed leadership to have an impact on collaboration. However, this study looked not only at the potential influence of knowledge and distributed leadership, but also at the combination of two and the influence they have together or when one or the other is lacking. Discussion is included regarding how to best support teachers engaged in collaboration and where to prioritize resources when working towards reform in mathematics.

The following chapter provides a review of literature to fully describe the existing relationship among teacher knowledge for teaching mathematics, principal distributed leadership, and conversations in teacher collaboration. The relationship creates the conceptual framework for the study including the methodology and data collection used to investigate the potential influences of teacher knowledge and principal distributed leadership.

Chapter Two: Review of Literature

To better prepare students for success in college and to meet the demands of the CCSS, there is a greater need for teachers to have a depth of knowledge in mathematics. The rigorous content and practice standards of the CCSS now require students to be able to solve problems and communicate about mathematics with both procedural and conceptual understanding (Sun et al., 2013). To help students gain this knowledge, teachers need to have specialized content knowledge in mathematics and a better understanding of content and student thinking in mathematics (Ball et al., 2008). However, to address the social, situational problem solving, and communication aspects called for in the standards, teachers also need knowledge about the social aspects of learning such as reasoning and communication (Ball et al., 2001; Nickerson, 2005).

Professional development is one way to help teachers gain the necessary knowledge for teaching mathematics. Effective professional development should include direct connections to student thinking to help teachers increase their knowledge, and should take place over an extended period of time (Sun et al., 2013). The professional development used to increase teacher knowledge in this study was built from the Developing Mathematical Thinking framework, which encompasses ideas of social learning theories and provides opportunities for teachers to develop their specialized content knowledge (Brendefur et al., 2011).

After participating in professional development, teachers can share and extend their knowledge through conversations occurring during collaboration with their peers, which can help influence changes in instruction (Nickerson & Moriarty, 2005). Effective collaboration should include a focus on student thinking and important mathematical ideas, and this can be easier when someone in the group has a deeper level of knowledge (Wood, 2007). The teacher with increased knowledge can often rise as an informal leader within the group as they work to help with questions arising from other teachers' classrooms and work to help their team better understand student thinking in mathematics (York-Barr & Duke, 2004).

Principal leadership can promote collaboration meetings as a priority where teachers can become informal leaders by sharing their knowledge (Dumay et al., 2013). Principals can set the tone and expectations for collaboration in their building along with providing a sense of shared leadership where teachers feel empowered to take on informal leadership roles (Supovitz et al., 2009). The principal must support collaboration and be involved in the conversations teachers are having as they work to improve their instruction in mathematics (Goddard et al., 2015).

The present study examined the potential effects of principal distributed leadership and teacher specialized knowledge in mathematics on the frequency of conversations about student thinking and instruction in mathematics during teacher collaborations. The following concepts found in the literature make up a conceptual framework through which this study will be viewed: (1) distributed leadership for advancing collaboration and development of teacher leaders; (2) teachers gaining specialized knowledge in mathematics through meaningful professional development; and (3) conversations during collaboration meetings for improving instruction in mathematics. Figure 2.1 shows how the researcher conceptualized the elements interacting based on the following review of literature.

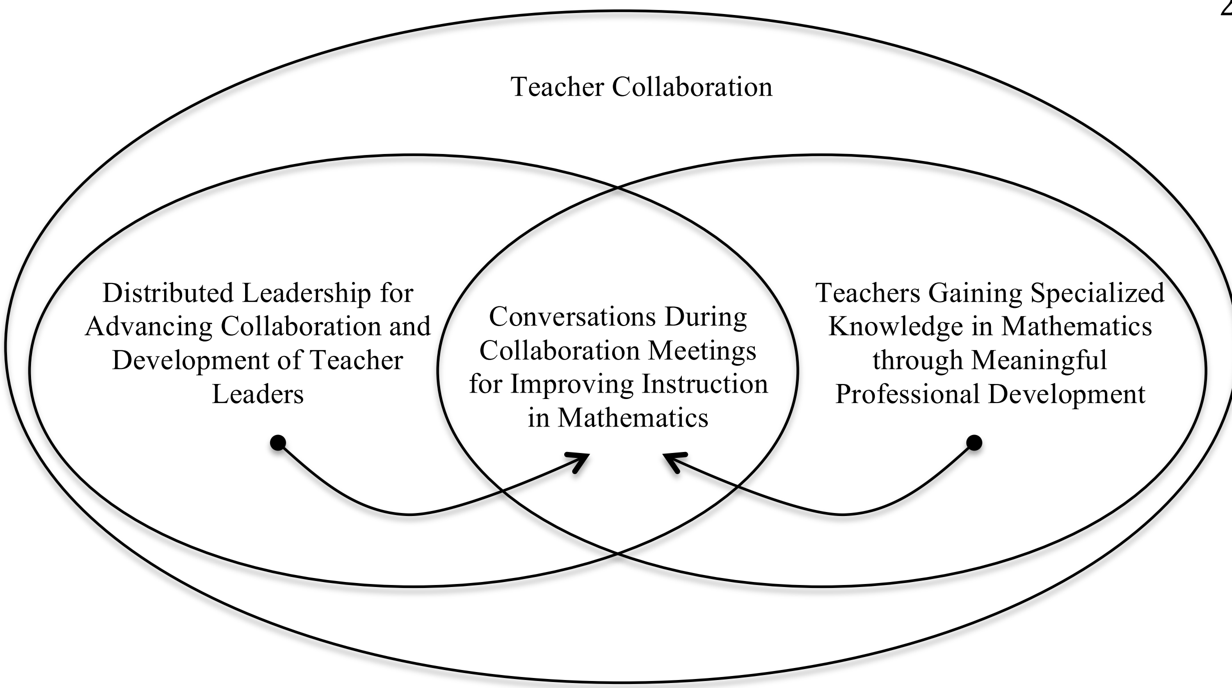


Figure 2.1. Conceptual framework for study

Distributed Leadership for Advancing Collaboration and Development of Teacher Leaders

School leadership can be viewed through many perspectives and includes various tasks and responsibilities. Rather than looking at leadership within a school as the role of an individual person, leadership can instead be viewed as a group or team effort and responsibility in an effort to meet the ever-changing demands of education (Harris, 2008). The leadership component of the lens through which this study is viewed is distributed leadership. This perspective on leadership "acknowledges the work of all individuals who contribute to leadership practice, whether or not they are formally designated or defined as leaders" (Harris, 2008, p. 31). An administrator utilizing the distributed leadership perspective allows leadership to be seen as the work of a collective group working towards a common goal.

Heck and Hallinger (2009) discussed the potential importance of looking at distributed leadership within a school. They engaged in a four-year longitudinal study to determine the influence of distributed leadership on a school's ability to build academic capacity and on student growth in mathematics achievement. Using survey data collected from teachers and students through multiple administrations over the four-year period, they were able to determine the influence of distributed leadership. They found that distributed leadership within a school and capacity building are related and potentially dependent on one another (Heck & Hallinger, 2009). The interdependent relationship was demonstrated as the schools that perceived stronger distributed leadership in their building also showed a better ability to build capacity for change. These connections were also associated with growth in mathematics achievement, which confirmed their assumption that leadership would have an indirect effect on student achievement. Heck and Hallinger found a need to distribute certain types of leadership, such as sustaining a focus on academic improvement and developing instruction. However, due to the type of data collection and analysis, it is not clear which of these tasks were most important and who should take on these leadership roles (Heck & Hallinger, 2009).

Neumerski (2013) discussed the need for looking at how leadership is enacted to truly understand when leadership has an impact on successful schools, and in order to do this well it is important to look at how various instructional leaders interact with one another. In Numerski's analysis of instructional leadership literature she highlighted how many leadership studies have only looked at individual leadership roles within a school, such as the principal, teacher leaders or coaches. She discussed the need to look at how these roles work together to support successful schools. In her analysis of these various forms of leadership, Neumerski used the distributed leadership perspective of Spillane, Halverson and Diamond (2004) to frame the types of leadership interactions within a school. A similar perspective will be taken to frame the leadership lens used in this study. A modified version of the conceptual framework is included to emphasize the portion of the model to be addressed within the discussion of the distributive leadership literature.

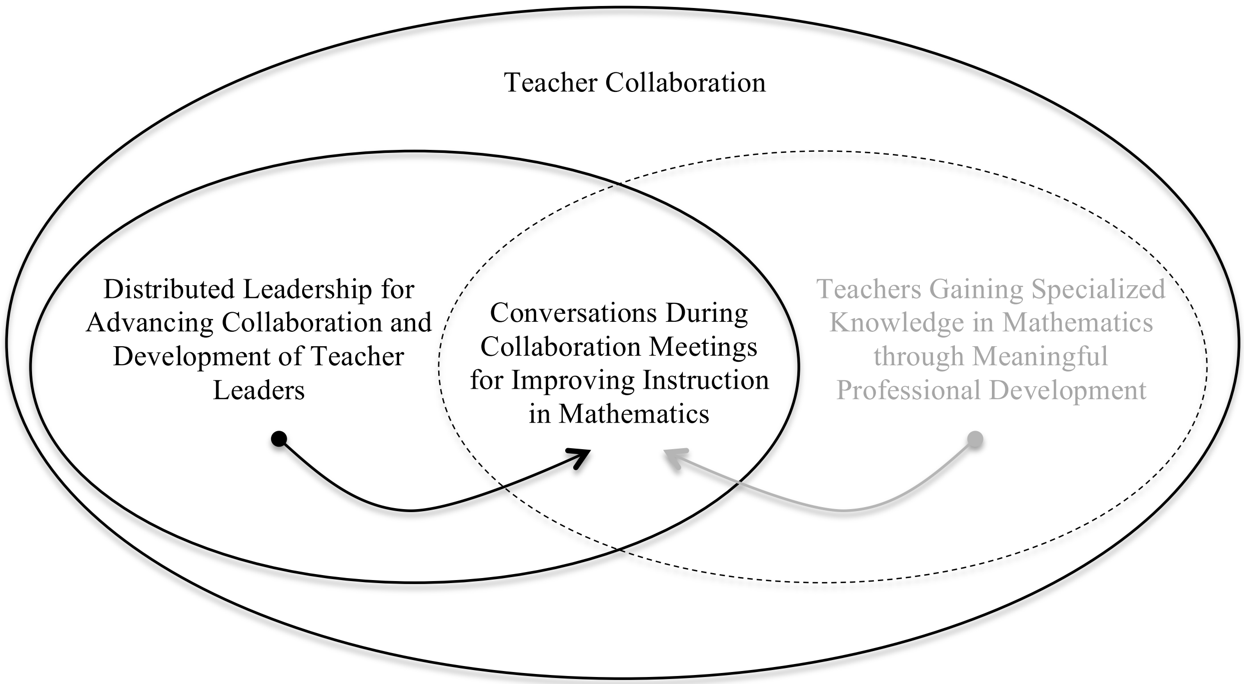


Figure 2.2. Modified Conceptual framework for study – Distributed Leadership Focus

Spillane, Halverson and Diamond (2004) framed a perspective of distributed leadership focused on leadership activities and the dynamics created through the setting and interactions of the leadership process. They stated, "Leadership involves mobilizing school personnel and clients to notice, face, and take on the tasks of changing instruction as well as harnessing and mobilizing the resources needed to support the transformation of teaching and learning" (Spillane et al., 2004, pp. 11-12). The researchers used prior research from distributed cognition and action theory to create a basis for their distributed leadership model. They discussed how cognition cannot be separated from the context in which it is gained, displayed or shared, which therefore makes it necessary to include the social context when discussing leadership activities and relationships. Given the need to consider context and cognition in leadership they define leadership as the interaction of the leader, their followers, and the situation, and to truly look at distributed leadership a focus on all three elements should be present.

In schools, the principals are often the people in formal leadership positions, but when they take on a distributed leadership perspective, they are choosing to involve others in leadership by creating an environment to promote engagement in leadership activities. Spillane et al. (2004) utilized the distributed leadership perspective to look at the leadership positions in schools and to go beyond the formal leadership roles such as the building principal and look at all those who play a role in leading aspects of change or movement towards a common goal. Leadership activities are subsequently able to be viewed as dependent on the resources available and the interaction between those in formal and informal leadership positions, and supports these authors' claim that a group of leaders working together and bringing their own unique knowledge and resources to the situation is more powerful than one leader working alone. Spillane et al. framed their perspective of distributed leadership around four central ideas: (1) leadership tasks and functions, (2) task-enactment, (3) social distribution of task enactment and (4) situational distribution of task enactment. These ideas will be used to frame the distributed leadership component of the framework for this study along with other components found in the review of leadership literature. The first three of these ideas (leadership tasks and functions, task-enactment and social distribution of task enactment) will be discussed by looking Spillane et al.'s view of the idea along with how additional literature supports or challenges the ideas. The final idea, situational distribution of task enactment, will be discussed later in the chapter by narrowing the scope of situational tasks to look at the distribution of knowledge during collaboration meetings.

Leadership Tasks and Functions

The sole purpose of some leadership tasks is to keep the school running smoothly. These tasks include items such as scheduling time during the day for teachers to meet, which requires a need for the leader to understand the contractual or personal restraints on time within their school. Tasks such as these create a structure and help provide the situation needed to support distributed leadership (Spillane et al., 2004). The structure also provides opportunities for discussions among leaders and followers.

The tasks of leadership range from providing a structure to allow distributed leadership to take place to the actual activities leaders engaged in throughout the school year (Spillane et al., 2004). The formal leader of the school provides the structure, which creates the means to enact leadership tasks. "We argue that structures, as meditational means, provide a basis for action in which people pick and choose in an effort to accomplish desired ends" (Spillane et al., 2004, p. 22). The structure a principal sets within the building can not only allow for distributed leadership to take place but also helps shape and define the tone within the school. Through strong leadership, building principals have the unique ability to be directly involved in the changes happening in their school, therefore having the capacity to influence the direction of change (Spillane & Kim, 2012).

School reform is, in part, dependent on the leadership at the building level. Through instructional leadership, principals must understand the purpose and help steer their teachers in the direction of the reform by creating an environment to support and encourage change

(Leithwood, Seashore, Anderson, & Wahlstrom, 2004). Principals can create an environment where teachers feel empowered to become involved in leadership. This helps build school capacity as the leadership becomes distributed among various members of the school creating a sense of community and commitment (Leithwood et al., 2004).

Investigating cases of leadership within educational settings, Stein and Nelson (2003) found it is not enough for principals to say they expect teachers to work towards continuous improvement, rather they must hold teachers accountable for engaging in the process. The researchers pointed out that one of the biggest ways principals can influence instructional changes and hold teachers accountable for continual learning in their building is through evaluations. Through the process of evaluations principals are able to highlight what they see as important elements, which will encourage teachers to align their practices with these elements (Stein & Nelson, 2003).

The evaluation system creates an important role for principals in sustaining reform efforts (Jaberg, Lubinski, & Aeschleman, 2004) and is included in one of the artifacts a leader uses as part of distributed leadership (Spillane et al., 2004). However, in turn, principals must ensure they are setting up an environment and providing the teachers with necessary tools to make the change. This includes principals gaining knowledge of how to make the change so they understand what they are supporting (Elmore, 2000).

In a review of methodology on leadership for learning, Hallinger (2011) discussed how building principals can, in large part, determine the values for instruction in their school. They do this by first examining their own value structure as they decide what they feel is an important focus, and then the focus is often transferred to the school when they set the tone for what their expectations will be for teachers. He pointed out how it is important for administrators to take the time to understand the context and current belief structure in their school to help them determine priorities. One of the ways principals are able to understand the context of their school and know what elements of the vision to push is by being involved with the instructional decisions taking place. With a focus on several recent empirical studies, Hallinger found that the principals' ability to understand the structure and current belief system within their school helps them to better understand the situation that will interact within the distributed leadership process. However, one of the challenges presented in this study was the ability to link specific leadership activities with a contextual situation due to the various factors at play in any given leadership situation.

Task-enactment

The second central idea of distributed leadership discussed by Spillane, Halverson and Diamond (2004) was the artifacts used to enact leadership activities. These can be tools, such as evaluation forms or symbols like the language used to communicate ideas. When an evaluation form is used as a leadership tool, the focus of the form can have a distinct impact on the goals set for instruction and the focus for support (Spillane et al., 2004). A form focused on a checklist of behaviors exhibited during classroom instruction is bound to drive a focus different from a form focused on students meaningfully discussing mathematics. These various artifacts can create constraints and define leadership roles as they affect how leaders are able to perform leadership tasks.

Social Distribution of Task-enactment

Spillane et al. (2004) created a perspective of leadership that goes beyond the formal leadership role of the school principal. A distributed leadership framework allows principals to examine the interactions among the leaders, the followers, and the situation by investigating the activities involved in the act of leading. They discussed the need for the formal leader to perform tasks and create a structure in which the form of leadership can thrive while also being an active participant in the process

> Leadership is not simply a function of what a school principal, or indeed any other individual group of leaders knows and does. Rather, it is the activities engaged in by the leaders in interaction with others in particular contexts around specific tasks. (Spillane et al., 2004, p. 5)

The distributed perspective in leadership can be helpful in looking at how leaders in a school come together to work towards a common goal and how leadership roles and activities might be spread between leaders and followers.

In a meta-analysis of the impact of various types of leadership, Robinson, Lloyd and Rowe (2008) found goal setting to be an important element of leadership as it allows for teachers and principals to work together to determine a team focus. These goals will then need to be continually revisited and protected as the team works to achieve them. Principals play a role in protecting the goals when they help weed out distracting or competing ideas and help teachers work through logistical and contextual hurdles (Robinson et al., 2008). Principals and teachers working together towards common goals can allow it to be easier for all parties to take a role in the leadership process, which provides support for the way Spillane et al. (2004) described task distribution in distributed leadership.

One role principals play within the school network should be involvement in the instructional decisions their teachers are making (Printy, 2010). Principals must actively work with teachers as they focus on teaching and student learning. The interaction helps them focus on a common goal as they work collaboratively to build knowledge about effective instruction (Stein & Nelson, 2003). When principals participate in efforts to reform instruction, they are automatically seen as buying into and supporting the efforts of their teachers. Principals should be familiar with and understand the intent of the changes teachers are making towards reform so they are able to support and provide meaningful feedback (Jaberg et al., 2004). The principals' involvement in setting and maintaining goals sets the stage for their involvement in the classroom. Involvement may include activities such as classroom visits and collaboratively looking at student work with teachers (Robinson et al., 2008). Principals who play a role in the teaching and learning that is taking place in classroom have been linked to high achievement (Robinson, Lloyd, & Rowe, 2008; Goddard et al., 2015).

Leaders must have a certain level of knowledge about reform efforts. Stein and Nelson (2003) referred to this knowledge as leadership content knowledge and described it as, "that knowledge of subjects and how students learn them that is used by administrators when they function as instructional leaders" (p. 445). This knowledge helps to connect learning and instruction with leadership. Brazer and Bauer (2013) pointed out that one aspect of principals being strong leaders is their knowledge of the instruction they are hoping to see from their teachers. If principals themselves do not have the knowledge, they may not understand and be able to fully support the efforts of their teachers and teacher leaders. The authors discuss the need to gain more knowledge of instruction in order to become effective instructional leaders can lead principals to question their own practice and understandings and continually seek to improve (Brazer & Bauer, 2013).

Principals' content knowledge can help them better understand what they are looking for as they visit classrooms and observe instruction. The content knowledge can then translate into finding ways to help support teachers (Stein & Nelson, 2003). Principals who use a distributed leadership model are able to rely on the shared knowledge within their school when their own knowledge is not sufficient in a particular area. The knowledge of other leaders within the school becomes a tool to be used in interactions and activities within the school (Spillane et al., 2004).

Informal teacher leaders developed within the group can have a strong influence over the beliefs and expectations of other group members (Pescosolido, 2001) and allows for leadership expertise to be shared among team members (Kennedy, Deuel, Nelson, & Slavit, 2011). The distributed leadership design can be an important element in school reform because it recognizes that no one person has all of the knowledge needed for change (Borko, Wolfe, Simone, & Uchiyama, 2003). Teachers benefit from resources that are available at their schools, so the lack of a resource such as knowledge can have an impact on the schools' ability to grow (Moolenaar, 2012).

Teacher leaders are often chosen by their peers to be leaders when they are able to demonstrate a high level of knowledge, and engage in collaboration and reflection (York-Barr & Duke, 2004). The increased level of knowledge can be demonstrated by the knowledge teachers have about a given subject area and in their instructional strategies (York-Barr & Duke, 2004). Teacher leaders become a part of the distributed leadership model as they interact with other leaders and followers to lead various aspects of change within their school (Spillane et al., 2004).

Situational Distribution of Task-enactment

Spillane et. al (2004) described how leaders and followers are able to influence each other in the process of distributed leadership, which allows for leadership qualities to be present in both groups as they interact with their situation. In this situation all parties must assume a role in the process as they transfer knowledge and ideas within a particular setting. The social context of the setting, such as the support provided by the school district, the location of the school, or student population, can play a role in what the leaders and followers can do or need to do within their roles. The context offers various tools and constraints to the enactment of distributed leadership, so they must be seen as part of the leadership since they affect how leadership tasks are enacted (Spillane et al., 2004).

In a comparison study of two schools implementing instructional changes, Borko, Wolf, Simone and Uchiyama (2003) found that one school was able to use the increased knowledge of a few teachers to enhance the knowledge and skills in mathematics in their school. Alternatively, the other school struggled with mathematics because they did not have anyone in the building to turn to with questions or concerns about their efforts to make change. Their study was able to demonstrate the potential benefit of having teachers with increased content area knowledge within a school to support changes in instruction (Borko et al, 2003).

Teachers with high levels of content knowledge have the ability to be powerful leaders when they are able to help others engage in meaningful conversations about their practice (York-Barr & Duke, 2004). The leadership position coupled with increased knowledge allows teacher leaders to have a more significant influence on teacher change than those in other leadership roles due to their direct connection to the classroom (Sun et al., 2013). The classroom connection can drive teachers to engage in conversations with teacher leaders about their instruction due to their dual position in leadership and as a classroom teacher (Spillane & Kim, 2012). In order to better understand the knowledge needed for these teacher leaders to influence their peers in making changes that will support the instruction required by the CCSS, it is necessary to look at the knowledge needed for teaching mathematics and how teacher leaders can gain that knowledge.

Teachers Gaining Specialized Knowledge in Mathematics through Meaningful Professional Development

To teach mathematics, teachers must have a depth of knowledge beyond what is required of individuals in many occupations. Teachers' mathematical knowledge must include (1) pedagogical content knowledge, (2) specialized content knowledge, and (3) an understanding of how students learn mathematics (Ball et al., 2008; Shulman, 1986). These three types of knowledge interact to allow teachers to support students' conceptual development of mathematical ideas and allow them to address student misconceptions that arise (Ball et al., 2001; Shulman, 1986; Silverman & Thompson, 2008). An understanding of content and pedagogy allows teachers to address both the content and process of student learning (Shulman, 1986). Without the knowledge and understanding of how students learn, teachers are unable to teach mathematics for conceptual understanding and make necessary connections for students to help guide student thinking and learning (Ball et al., 2001; Silverman & Thompson, 2008).

Researchers have highlighted the need for teachers' specialized content knowledge in allowing them to analyze student solution methods and use student thinking as a way to guide students along a path from informal to abstract ideas. This knowledge is deemed specialized because it is beyond what the average person would need to use and apply the same mathematics in everyday situations (Sztajn, Confrey, Wilson, & Edgington, 2012). Pedagogical content knowledge is the knowledge teachers must have in order to carefully select tasks and ask questions to facilitate student learning opportunities and tap into student thinking. Teachers must be able to guide that learning by knowing when to press for connections to other situations and areas of mathematics (Sliverman & Thompson, 2008). Due to the complex nature of specialized and pedagogical content knowledge, the quality of mathematics instruction greatly depends on the teachers' knowledge of the content. Through assessments of the knowledge and skills needed for teaching mathematics, it has been found that the level of teacher content knowledge can positively predict gains in student achievement (Ball, Hill, & Bass, 2005). A modified version of the conceptual framework is included to emphasize the portion of the model to be addressed within the discussion of the need for teacher to gain specialized content knowledge for teaching mathematics.

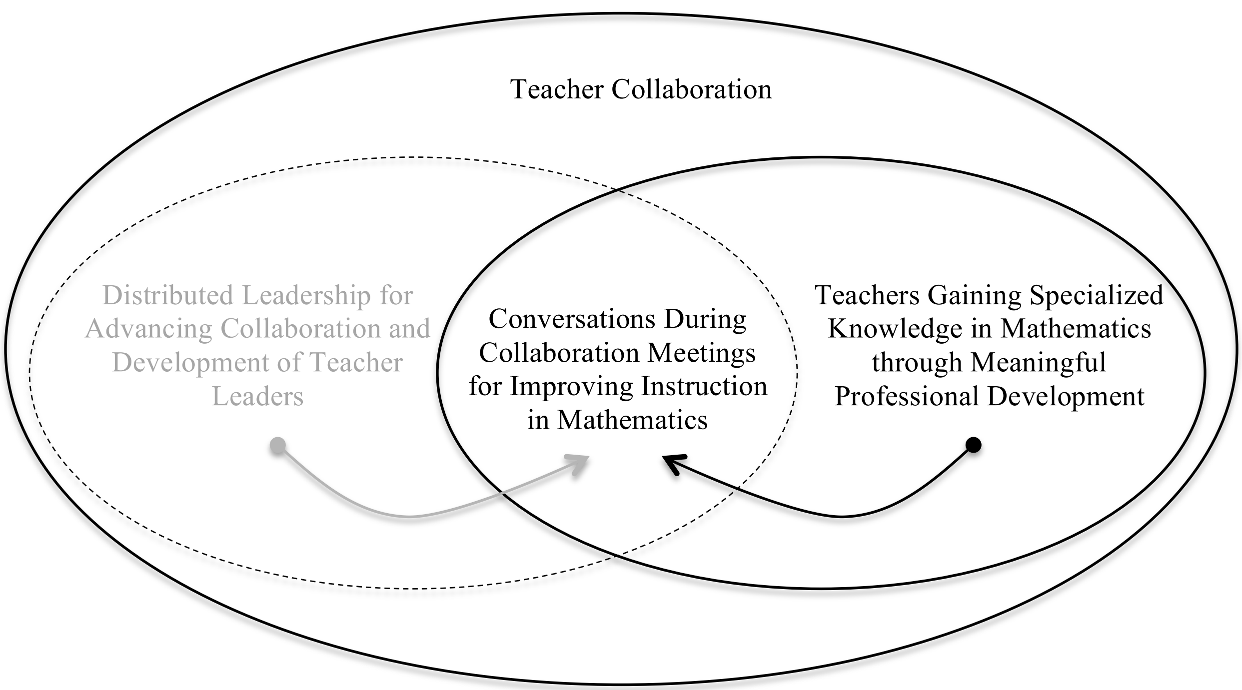


Figure 2.3. Modified Conceptual framework for study – Specialized Content Knowledge Focus

Mathematical Knowledge for Teaching Framework

Ball et al. (2008) described this knowledge as the Mathematical Knowledge for Teaching and created a framework within which to highlight the many aspects of this necessary knowledge. Ball et al. clarified the meaning of MKT as:

> the mathematical knowledge needed to carry out the work of teaching mathematics. Important to note here is that our definition begins with teaching, not teachers. It is concerned with the tasks involved in teaching and the mathematical demands of these tasks. (p. 395)

Teachers need to do many different things when teaching mathematics and to foster student learning, including tasks such as teaching the lesson, planning, assessment, determining student practice and interacting with other teachers and leaders about what is happening in the classroom. "These tasks require significant mathematical knowledge, skill, habits of mind and insight" (p. 398) and involve specific pieces of knowledge necessary for teaching mathematics (Ball et al., 2008).

To capture all types of knowledge needed for teaching mathematics, Ball et al. (2008) discussed the various types of subject matter knowledge and pedagogical content knowledge, which allows for the connection between mathematics and teaching to be addressed. The subject matter needed for teaching is broken up into three components. The first is the need for teachers to have common content knowledge (CCK), and includes knowledge held by those who know mathematics and use it in various settings. Teachers use this knowledge when using terminology or performing mathematical procedures (Ball et al., 2008).

The second component of subject matter knowledge necessary for teaching is specialized content knowledge (SCK). This is knowledge that not everyone needs and is unique to teaching. This knowledge includes aspects such as identifying and evaluating student errors and knowing which models or contexts are appropriate for illustrating and developing various concepts and ideas (Ball, Thames, & Phelps, 2008). Such knowledge is important for teachers because it allows them to make the content accessible for students and enables teachers to better guide students in developing important mathematical ideas.

A third component in teacher subject matter knowledge is horizon content knowledge. This knowledge is demonstrated in the teachers' understanding of how the mathematical ideas progress and connect over time allowing them to focus on big ideas in their instruction (Ball et al., 2008).

The second aspect of mathematical knowledge needed for teaching includes three components of pedagogical content knowledge. The first of these is the knowledge of content and students (KCS). Teachers will need to apply their content knowledge to how students will be able to learn that knowledge by understanding how students might think about and develop ideas. Knowledge of content and students also includes the teachers' ability to anticipate and address student misconceptions as they arise during learning (Ball et al., 2008).

The second component of pedagogical content knowledge is the teachers' knowledge of content and teaching (KCT). Knowledge is applied as teachers plan for instruction and facilitate mathematical learning among students. As a part of KCT, teachers must know when to press students with another problem or number set and know when to ask questions about student thinking to help students generate ideas and make connections. Teachers must be able to determine which student ideas to highlight for class discussions and know how to use those discussions to move through instruction (Ball et al., 2008). The final part of the pedagogical content knowledge needed for teaching mathematics is the knowledge of content and curriculum. The component of content and curriculum knowledge was added to the framework as a connection to Shulman's (1986) ideas about the need for teachers to have curricular knowledge. Teachers apply pedagogical content knowledge when they decide how to use their particular resources to plan for instruction.

Highlighting the Need for Specialized Content Knowledge

In her study of content knowledge of United States and Chinese teachers, Liping Ma (1999) found that Chinese teachers have a better understanding of the fundamental elementary mathematics they were teaching. The gap is similar to the gap in students' mathematical achievement between the two countries. Many in the United States believe elementary mathematics standards are a set of simple rules and procedures that anyone can teach. However, for a teacher to truly understand the structure of mathematics and how to teach it to young students, is much more complicated (Ma, 1999). If teachers do not have this understanding when they complete their schooling, they are unlikely to have future opportunities to gain or further their knowledge of elementary mathematics (Ma, 1999).

Linking Pedagogical Knowledge to Instruction

Learners of mathematics should be placed in circumstances where they are encouraged to build knowledge for themselves and demonstrate their understanding of mathematical situations (Brendefur et al., 2011). When students learn through their own experiences with mathematics, they are able to see mathematics as a tool to solve problems in their world rather than a set of procedures to be applied to a particular problem (Gravemeijer & van Galen, 2003). Teachers need to be able to select mathematical tasks that allow students to engage in productive struggle through problem solving and leave behind an important piece of mathematical knowledge that they can later apply to other mathematics and real-life situations (Hiebert, 1997).

One important instructional goal is to move students from using informal models grounded in context to more formal models (Smith, 2003). To meet this goal, teachers must understand how students' informal representations of a problem can initially help them make sense of the mathematics, and then help them formalize their ideas (Smith, 2003). Students should begin by directly modeling a situation, and over time these early informal models can be connected to more formal, abstract models used to solve mathematical problems (Gravemeijer, 1999). Students should be encouraged to look for similarities and differences in problems and in their modeled solution strategies while seeing each model as a representation of the situation with varying levels of abstraction (Smith, 2003).

Instructional tasks and teacher questioning should be centered on helping students develop key developmental understandings (KDUs) in mathematics (Simon, 2006). These KDUs can be thought of as overarching mathematical ideas that press students to make connections between mathematical topics and ideas. For students to develop these KDUs in the classroom, teachers must be able to help students make connections by choosing activities and experiences to aid in their development (Simon, 2006). The ability to choose meaningful tasks and question students in a way that supports their development of a KDU is dependent on the teacher's understanding of the mathematical ideas and how they can be pieced together to form big ideas (Simon, 2006).

One of the ways teachers can help students develop these important KDUs is by establishing a hypothetical learning trajectory (HLT) (Simon & Tzur, 2004). Using such a trajectory, a teacher can try to understand where students are in their development of concepts and ideas and determine a path to help them meet a particular goal such as a KDU (Simon & Tzur, 2004; Clements & Sarama, 2004). A teacher can develop a HLT through research and determining the best possible tasks, questions and activities to guide students; however, the actual enactment of the trajectory in the classroom must always be differentiated based on the individual student or classroom (Simon & Tzur, 2004; Clements & Sarama, 2004). Teachers need to individualize and adapt the HLT is due to the potential differences in what the student(s) already know, what they do not know and what previous experience they are bringing to the situation (Simon & Tzur, 2004).

As teachers work to better understand their students' path towards KDUs through the use of HLTs, they will need to find ways to better understand their students' mathematical knowledge. When teachers spend time analyzing student work and/or listening to their students reason about problems, they are better able to describe their students' mathematical knowledge (Simon, 2006; Simon & Tzur, 2004; Ma, 1999). Analyzing work can be difficult for teachers who do not fully understand the mathematics they are teaching because they are not able to meaningfully address the student questions. If a teacher struggles to explain or model an algorithm or situation, then it will be difficult for them to ask the same of students (Ma, 1999).

Social Learning Theory

Vygotsky's theory of social learning includes two elements often present in the classroom instruction described above. The first is that social interactions can help drive cognition, as they provide a context for making sense of new situations and ideas (Vygotsky, 1978). The second important element is that the tools we have available in a given situation mediate our behavior. These tools allow individuals to interact with the environment and include technical tools, environmental tools and language (Vygotsky, 1978). One environmental tool can be the increased knowledge of a member of the team.

Vygotsky (1978) viewed tools as a way to make sense of our world and gain knowledge as we internalize and meaningfully utilize the tools. However, the tools people choose to use will change and evolve as they continue to learn and grow. He discussed that a larger part of learning is solving problems that arise out of everyday situations and require individuals to apply and adapt tools to solve. Solving these problems may include modifying and/or formalizing tools or choosing better, more efficient tools. Vygotsky's theory of social learning focused on people being pushed to learn things beyond their current level of mastery which allows them to continually increase their knowledge (Vygotsky, 1978).

Situated learning theory also describes how individuals learn in a social context. Situated learning theory posits that knowledge is co-constructed through interactions among group members (Driscoll, 2004). Driscoll (2004) described this theory as "knowledge accrues through the lived practices of the people in a society" (p. 158). Through interactions with other members of a community, individuals begin to develop a set of expectations, norms and specific language to be used in our interactions (Driscoll, 2004). These guidelines for interaction help to create a community of learners where teachers are able to work together and provide ideas and influence over the instruction in one another's classrooms. However, many teachers learned mathematics in a teacher-centered manner in which the teacher held knowledge to share with students, and this model can make it difficult for them to engage students in social, problem-solving contexts (Nickerson & Moriarty, 2005). Meaningful professional development can assist teachers in gaining both the necessary content knowledge and reasoning skills needed to teach mathematics.

Gaining Knowledge through Professional Development

Professional development should be constructed in a way that focuses on teacher learning and builds knowledge of content (Borko, 2004; Marrongelle, Sztain, & Smith, 2013; Sun et al., 2013). Creating professional development settings in which teachers are actively involved in learning has showed positive effects on practice and allows for the construction of knowledge needed for teaching mathematics (Sun et al., 2013). The focus on specific content has been linked to gains in teacher knowledge and changes in practice (Sun et al., 2013). Teachers must be able to understand how student thinking develops and then be able to connect this understanding to their existing mathematical content knowledge. In order to successfully make these connections, it is important to provide professional development that focuses on content to help teachers develop a deeper understanding of the mathematics (Borko, 2004).

Engaging teachers in activities such as solving rich mathematical problems can help facilitate this understanding of content (Borko, 2004). When relating these ideas to professional development to support the transition to the Common Core State Standards, it is vital for professional development sessions to focus on specific content linked to practice, such as standards and assessment (Sun et al., 2013). The focus can be addressed through both the content and the practice standards for mathematics in the Common Core State Standards (Marrongelle et al., 2013).

Hughes, Brendefur and Carney (2015) provided an example of using rich mathematical problems to facilitate teacher learning as they describe a task used in a large-scale professional development session. The selected task demonstrated how the focus on content is able to support teachers in their development of structural mathematical ideas. The problem was specifically selected because it allowed for deep engagement as teachers visualized the contextual situation through making connections among models for solving, and pushed teachers into a state of cognitive dissonance where they could work through important ideas to make sense of the problem. The learning experience not only benefits teachers by increasing their content knowledge, but can also translate to tasks they might use successfully in the classroom (Hughes et al., 2015).

Many studies have discussed the need for professional development to be provided over an extended period of time in order to see gains in knowledge and change in teachers' instructional practice. which involves multiple sessions and many hours of trainings focused on meaningful ideas (Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2002; Marrongelle et al., 2013; Sun et al., 2013). Extending professional development over a longer period of time allows for teachers to build their knowledge (Marrongelle et al., 2013). In a study by Garet et al. (2001), teachers indicated that professional development conducted over a longer period of time had a larger influence on their practice (Garet et al., 2001). When teachers see changes in student thinking or student achievement, they are more likely to believe in the change. It take time to effect student achievement me, which in turn supports the need for meaningful professional development to be provided over an extended period of time rather than in a short session (Guskey, 2002). Sun et al. (2013) found that teachers who take part in long-term professional development are also more likely to provide support to peers.

Conversations During Collaboration Meetings for Improving Instruction in Mathematics

Conversations during collaboration can be a way for teachers who have specialized knowledge about teaching mathematics to share that knowledge with their colleagues. In their discussion of distributed leadership, Spillane et al. (2004) discussed the idea of situational distribution of task enactment as an important feature of successful distributed leadership, which includes the environmental and situational variables that impact the distribution of leadership tasks. Collaboration meetings can provide the situation to allow for the distribution of knowledge, which helps allows for the enactment of distributed leadership tasks. The environment created for collaboration and support given during this time can be important contextual variables in allowing informal leaders with specialized knowledge to support their peers.

Collaboration is one of the most common ways for teachers to influence their peers as it provides an opportunity for teachers to collectively engage in professional learning (Riveros, Newton, & Burgess, 2012; Nickerson, 2005). The work done during collaboration can support a teachers' ability to continually learn and improve their instruction (Slavit et al., 2013; Taylor, 2004). Leigh and Spillane (2010) claim that conversations occurring during collaboration create informal learning opportunities among colleagues as it gives them time to engage in conversations centered around their current teaching practice and to make connections to more formal learning settings, such as professional development. They emphasized that these informal learning opportunities created through collaboration have been shown to be significantly associated with changes in teacher practice.

West (2008) observed that when teachers engage in conversation during collaboration, they can increase their willingness to take risks as it can allow teachers time to reflect on their current practice. She discussed a model in which teachers engage in discussion with content coaches to focus on issues of classroom instruction and found that through collaborative discussions around content, teachers can solve problems and plan for students to engage in rigorous problem solving (West, 2008). Through collaboration, teachers can work to find ways to best assess student thinking to help guide lesson planning, and then focus on using evidence of student learning to inform whether or not their instruction is effective. However, West also highlighted that without a depth of knowledge about the content, it can be difficult for teachers to plan meaningful lessons and determine how students are thinking. Collaborative discussions with someone with a higher level of content knowledge can support teachers in this work.

In a study of three schools implementing reform, Strahan (2003) found that a common grade-level meeting time allowed for teachers to engage in discussion around what they were seeing their students do in the classroom. These discussions allowed teachers to use ideas that had shown success in another classroom or get suggestions on how to address an issue with student thinking in their own classroom. These discussions created a culture of learning and focus on student achievement in the building due to the focus on what students needed to know to be successful.

Focus of Conversations in Collaboration

In a study investigating the types of conversations teachers engage in during collaboration time, Taylor (2004) described the difference between two types of conversations: congenial and collegial. He pointed out that congenial conversations are friendly and include elements such as telling stories about teachers' lives and their classrooms. Collegial conversations are focused on professional issues related to teaching and student thinking aligned to a common vision and common goals. These collegial conversations can be likened to teachers engaging in continuous professional development through collaboration with their peers. Taylor highlighted how elements such as the physical location of colleagues and potential differences in identification and philosophies, can influence levels of collegial conversations. Teachers who have similar beliefs about how students learn and teach students at a similar grade level seem to have more conversations that allow them to work towards a common goal.

Teachers should be focused on specific elements of their practice or student achievement, allowing them to narrow their ideas and questions. Focusing on the instruction and student thinking happening in their classroom allows teachers to immediately apply and use new ideas. The discussion of ideas and focus on content and student learning creates a culture of informal action research among the team of teachers as learning together and working improve their instruction (Taylor, 2004).

Slavit et al. (2013) echoed the importance of discussion focusing on content in their study about how teachers engage in student learning data during collaboration. The researchers found that the focus of the discussion was more important than the duration. When teachers spend time in collaboration only sharing stories, they are not focusing on meaningful learning opportunities, but rather discussing events and external factors to their classroom environment. Slavit et al. concluded that collaboration becomes more productive when it is focused on student thinking highlighted by investigating student work. The focus on student thinking helps focus the conversations on instruction and student learning, both of which are factors controlled in part by the classroom teacher.

Similar to professional development, teacher collaboration meetings should be focused on professional issues and teacher learning (Sun et al., 2013). In collaboration, teachers should be focused on the issues of student thinking arising in their classroom. This includes discussion about what is and is not working and asking questions of their peers (Wood, 2007).

A teachers' ability to meaningfully discuss what is present in the student work and ask questions to guide the discussion can be connected to their level of content knowledge (Slavit et al., 2013). However, interaction with peers with higher levels of knowledge in a subject area is only helpful if the conversation is in-depth and related to the reform efforts, so teachers must be willing to prioritize productive conversations in collaboration meetings (Coburn et al., 2012; Slavit et al., 2013; Taylor, 2004).

Teacher Knowledge in Collaboration

Teachers can help each other make changes in practice by focusing on content, which can initially be developed through professional development (West, 2008). When the teachers are able to share the knowledge they have gained through external situations in collaboration with their colleagues, change in knowledge at one level is able to affect change at other levels (Burt, 2000). In a study about how teachers can diffuse information from professional development, Sun et al. (2013) described how type of change in knowledge occurs through collaboration by saying, "through collegial interactions, teachers who may or may not participate in professional development programs can benefit from these programs by interacting and learning from professional development participants" (p. 345). Some teachers may not be ready to plan meaningful lessons for students without the help of someone with high level of knowledge in the content area. The knowledge can help them focus on structural ideas within the lesson and determine how students might respond (West, 2008). Two crucial components of strong relationships among peers in collaboration meetings are the depth of conversations and a high level of knowledge, both of which can enhance sustainability of reform in schools (Coburn, Russell, Kaufman, & Stein, 2012).

Teacher Support in Collaboration

One of the ways this change can be influenced is through teachers with more knowledge within a subject area sharing ideas and activities they have already been using in the classroom (Penuel et al., 2006). Studies have shown that when teachers had access to peers who had already begun to make changes in instruction, they were more likely to make changes in their own practice, which demonstrates that who teachers collaborate with matters (Penuel, Frank, & Krause, 2006; Franke, Carpenter, Levi, & Fennema, 2001; Sun et al., 2013). Engaging in conversations about student learning can help teachers be more likely to take risks and make changes since they can press each others' understanding through discussion and questioning (Kennedy et al., 2011). Collaboration can be an important component in teachers' ability to change their instruction because it provides continual support for improvement (Nickerson & Moriarty, 2005).

Tenuto (2014) conceptualized a model that included five components for cultivating democratic professional practice in education. The model focused on advancing leadership within a school system by sharing various leadership responsibilities. She discusses how the practice of sharing leadership can help build capacity within schools and allow all members to become actively involved within a community. One of these elements in her model is the need for teachers to be willing to listen to ideas and opinions different from their own. Sharing data and expertise in this way may make conversations more productive for educators who are working to improve teaching in mathematics. Tenuto explained that when teachers are open to other ideas, it creates an environment where teachers are able to continually learn from each other, allowing them to absorb new skills and ideas to use in their classroom. Slavit, Nelson and Deuel (2013) provided further support for the need for teachers to be open to changes in their practice. They added that teachers with an open mind are able to pull more from conversations occurring during collaboration meetings because they are looking for ways to improve rather than trying to defend their past/current actions.

Leadership Support of Collaboration

Leadership can improve the overall school community by influencing teachers' attitudes, school culture and levels of collaboration. When leaders are able to have a direct effect on a school community, they also have an indirect effect on student achievement (Leithwood & Sun, 2012; Dumay et al., 2013). Principals play a central role in the collaboration network when they are involved in creating the vision and goals for school collaborations (Spillane & Kim, 2012). Principals can support teachers' focus and direction in collaboration to concentrate on improving instruction, which has been shown to support gains in student achievement (Goddard et al., 2015).

When principals are involved in the instructional changes teachers are making, they can help create a culture that includes collaboration among teachers and promotes the development of teacher leaders (Supovitz, Sirinides, & May, 2009). Principal leadership can help facilitate high levels of collaboration, which have been linked to changes in teacher instruction (Supovitz et al., 2009; Borko, Wolf, Simone, & Uchiyama, 2003; Printy, 2010). When administrators are able to share leadership responsibility within their schools, they are helping with the emergence and development of informal teacher leadership that may not be present otherwise (Supovitz et al., 2009).

In a review of literature on the elements that support successful teacher collaboration, Teague and Anfara (2012) discussed that a principal can play an important role in the successful implementation of a professional learning community since they are able to support the structure and set expectations. Through their actions, principals are able to set the tone for relationships within their building, which demonstrates the behavior expected of teachers during collaboration conversations. Printy (2010) supported the need for principal expectations and behaviors when she discussed how principals are also able to set the tone for relationships within their building and can model the behavior expected in teacher collaboration meetings. Improvements in instruction and gains in student achievement are more likely to occur when relationships are a focus within the school. According to Printy, focus increases the connectedness among teachers, which in turn, builds trust among teachers (Printy, 2010).

Teague and Anfara (2012) also said that principals are able to create a structure for collaboration by providing time during the day for teachers to meet and can help make the meetings productive and focused by setting expectations for teachers to focus on student learning during the meeting times. Supporting this idea, Supovitz and Christman (2005) highlighted the importance of protecting the collaboration time for teachers and keep collaboration time focused on student learning by not allowing it to be monopolized by other logistical tasks or requests from the principal.

The Need for Distributed Leadership and Teacher Specialized Content Knowledge in Collaboration

Collaboration has been shown to be one of the best ways for teacher leaders to influence their peers (Riveros et al., 2012, Nickerson, 2005), but the degree of influence can be dependent on leadership and knowledge. Principals with a distributed leadership perspective and access to teacher leaders with specialized content knowledge can both help allow teachers to have meaningful conversations in collaboration focused on making the instructional changes called for in the CCSS.

Teachers must possess a strong foundation of both subject matter knowledge and pedagogical knowledge in mathematics to foster student learning. This knowledge goes beyond what a typical person needs to know about mathematics and it allows for teachers to tap into student thinking and help them make connections to important mathematical concepts (Ball et al., 2008). Informal teacher leaders can gain this knowledge through professional development and use conversations during collaboration to share this knowledge with their peers (Sun et. al., 2013).

In their article about applying a distributed leadership framework, Kennedy et al. (2011) recommended creating a culture of shared leadership within the school to help facilitate a shared vision. School leaders must balance trust and accountability as they allow for teachers to take on leadership roles while still holding all accountable to high standards focused on a shared vision. Kennedy at al. stated, “leaders who practice distributed leadership recognize the need to draw upon and build from the expertise of teachers” (p. 23), which demonstrates the need for teachers to be a part of the process.

When elementary principals apply a distributed leadership philosophy within their school, it creates an environment where leadership is shared through the interaction of leaders, followers and the immediate situation. In this model, the principal as the formal leader allows for others to take on informal leadership roles and enact leadership tasks. This supports the notion that a group of leaders working together is often stronger than an individual (Spillane, Halverson, & Diamond, 2004). When people in informal leadership positions have specialized knowledge, they are able to apply and share this knowledge in various situations present in the school. The knowledge becomes a tool that can be utilized in the interactions of a distributed leadership model.

Summary

This study has been conceptualized through a review of literature related to teacher content knowledge in mathematics, professional development, conversations occurring during collaboration and principal distributed leadership. The review of literature discussed the importance of distributed leadership in education in supporting and sustaining reform efforts in mathematics. A distributed leadership model looks at the interaction among formal and informal leaders, followers and their situation and the activities engaged in through those interactions (Spillane et al., 2004). Elementary school principals can help their teachers make meaningful changes in instruction by supporting and engaging in their continual learning and growth and providing time for teachers to work together in collaboration (Goddard et al., 2015).

Along with leadership support, there is a need for teacher knowledge in mathematics and an understanding of how students learn to reason about mathematics in order to help students gain a deep understanding (Ball et al., 2001). Professional development is one way to help teachers gain this necessary knowledge in mathematics. Teachers who engage in professional development have the ability to take on an informal leadership role by providing support to their peers through conversation occurring during collaboration as they work together to better understand student thinking and improve their instruction (Sun et al., 2013). However, it is important for these meetings to be prioritized at the building level, which can be the result of principal distributed leadership. Principals can help collaboration meetings be more productive by setting expectations and supporting the work of their teachers during collaboration (Dumay et al., 2013).

Given these potential connections, this study investigated the level of influence teachers with specialized content knowledge in mathematics and principal distributed leadership have on the frequency of conversations related to student thinking and instruction in mathematics during teacher collaboration meetings. The study focused on the conversations occurring during collaboration and the influences of professional development and principal distributed leadership to examine whether a link could be made between one or both of these factors.

Chapter Three: Research Methods

The desire to examine the potential benefits of elementary teachers gaining and sharing specialized knowledge in mathematics drove the research for this study. The literature provided a framework for investigating two potential influences on the frequency of conversations teachers have during collaboration meetings: (1) distributed principal leadership and (2) teacher specialized knowledge in mathematics. Quantitative methodology was determined to be the most appropriate way to address both of these potential influences for population included in the study. Quantitative methodology allowed the researcher to summarize the large amount of data to determine the potential influence of distributed leadership and elementary teacher specialized knowledge on teacher conversations during collaboration (Krathwold, 1998; Privitera, 2015).

Research Design

This study utilized quantitative methodology and collected data through an online survey. The research design was a non-experimental group comparison with the comparison groups determined by the presence or absence of a MGC teacher on the grade level teaching team. A MGC teacher in this study was a teacher who has completed at least six of the seven courses in the MGC graduate program. The purpose of the comparison groups was to determine the level of influence a MGC teacher had on the frequency of mathematics conversations about student thinking and instruction in mathematics occurring during team collaboration meetings. A second comparison was made between the level of principal distributed leadership in the building and the frequency of mathematical conversations occurring during team meetings. The final comparison was completed by looking at the interaction between the groups created by both factors (MGC and distributed leadership) to determine if the presence of both factors created a larger influence on the frequency of mathematics focused conversations than one factor did alone. A 2x2 factorial ANOVA was used for all comparisons, which assisted in identifying if the there was a significant difference between the group scores on the frequency of conversations about student thinking and instruction in mathematics and if there was significance in the interaction of the two factors (Privitera, 2015).

Survey methodology was chosen for the data collection because it allowed for a fast, cost-effective way to collect a large amount of quantitative data (Dilman, Smyth, & Christian, 2009). The data were collected from a group of 109 elementary teachers regarding their frequency of conversations in collaborations around mathematical ideas and student thinking while also getting information about the administrative leadership within their school. The closed-ended questions included all possible frequencies, and were a quick way for teachers to respond to the questions stems (Dilman, Smyth, & Christian, 2009). Floyd and Fowler (2009) discussed how surveys completed on the internet have the potential to allow respondents to answer more honestly because respondents are not in the presence of the researcher so they may not feel pressure to answer in any particular way.

In this study, the construct of increased knowledge for teaching mathematics was operationalized using the teachers' assumed knowledge gained through the MGC graduate program. Throughout the program, teachers are asked to participate in class discussions, engage in solving mathematical tasks and spend time reading and reflecting on research in mathematics education. In each class they also spend time looking at student work to evaluate student thinking and determine steps for instruction. By participating in this program, teachers are gaining a deeper knowledge of how students learn mathematics while also strengthening their subject area content knowledge (Initiative for Developing Mathematical Thinking, 2012). The MGC program has also been able to demonstrate gains in participant knowledge through assessments from the Learning Mathematics for Teaching (LMT) Project (Hill & Ball, 2004; Ball, Hill & Bass, 2005) administered before and after several of the courses included in the program (Initiative for Developing Mathematical Thinking). The results of the comparison between the MGC teacher group and comparison group has the potential to be useful to the developers of the MGC program while also providing useful information for the developers of other professional education programs. A primary purpose of the program is to create informal or formal leaders in mathematics, and demonstrating a difference in the conversations occurring between groups would help support the successful creation of these teacher leaders. School district and building level leaders may also be interested in the results of the comparisons. If the results show the MGC graduates have a positive effect in the conversations occurring in the collaboration meetings, it could support a district's decision to help other teachers through the program.

While the construct of principal distributive leadership can be viewed in many ways, for this study it was narrowed to looking at the frequency of distributed leadership administrator activities and administrators' ability to set the tone and expectation for continual improvement at the building level. The review of literature indicated both of these leadership aspects have a direct effect on teacher collaboration (Supovitz et al., 2009; Borko, Wolf, Simone, & Uchiyama, 2003; Printy, 2010). Since many school districts have set aside time for collaboration, including all school districts represented in this study, the results of this comparison between frequency of principal administrative leadership and frequency of mathematics conversations in collaboration had the potential to provide information to school districts and the field of education in general about the factors that influence structured collaboration time.

Research Questions

This study addressed the following questions:

1. Does the presence of a MGC teacher with an increased level of specialized content knowledge influence the frequency of conversation about student thinking and instruction in mathematics?
2. Does the level of principal's distributed leadership at the building level influence the frequency of conversations about student thinking and instruction in mathematics?
3. Does the presence of a MGC teacher with an increased level of specialized content knowledge and the presence of principal distributed leadership have additional influence on the frequency of conversations about student thinking and instruction in mathematics than one factor has on its own? In other words, does the interaction between these two variables have additional influence on the frequency of the desired conversations?

Hypotheses

Ho_1 – The presence of a MGC teacher makes no significant difference in the frequency of conversation about student thinking and instruction in mathematics.

Ho_2 – The principal distributed leadership present at the building level does not influence the frequency of conversation about student thinking and instruction in mathematics.

Ho_3 – The presence of a MGC teacher and the presence of principal distributed leadership does not have additional influence on the frequency of conversations about student thinking and instruction in mathematics than one factor has on its own.

Population

The population for this study was elementary teachers in the Mathematics Consulting Teacher Endorsement Graduate Program in a Northwest University in the United States. Since the inception of the MGC program in 2012, 33 elementary teachers have completed at least six of the seven courses required for earning the graduate certificate or endorsement. Some of these teachers have taken various roles, such as instructional coaches outside of the classroom, but many of the teachers have continued as classroom teachers. This study looked only at the population of MGC teachers that have remained in the elementary classroom (kindergarten - 6^{th} grade) after completing (7 courses), or almost completing (6 courses) the program. This group consisted of 26 teachers in eight schools districts located in the Pacific Northwest.

Participants

The participants for the study were grade-level teams of elementary school teachers. For this study, the researcher uses the term "team of teachers" to refer to a group of two to four teachers teaching the same grade level at the same elementary school. Each team of teachers delivered instruction for the same subjects throughout the school day. In each participating district, time had been set aside for these teams of teachers to engage in collaboration.

In order to obtain a group of MGC teachers who are currently teaching in an elementary school and have a potential comparison school within their district, it was necessary to narrow the group of 26 MGC teachers. The researcher removed three elementary teachers who have completed the program, but were currently teaching in a charter school or school district with only one elementary school because of the additional external factors introduced by trying to pair them with a comparison school. The researcher additionally removed one teacher who has completed the program and teaches in another state, and removed one teacher who has completed the program but teaches in another geographical area, which could have introduced other factors. After making initial contact with principals, three additional elementary MGC teachers were removed from the list due to conflicts within their school. After the list was narrowed, 18 MGC elementary teachers remained from three school districts.

The two groups for the study were the teaching teams that include a MGC teacher and comparison teams without a MGC teacher. The groups are referred to as the MGC group and the comparison group. The comparison groups were within the same school district and chosen based on finding similar free and reduced lunch percentages. The MGC group consisted of 18 teaching teams. These 18 teams included a total of 52 teachers including the MGC teacher on each team. Since the grade level teams were distributed across all K-6 grade levels, the researcher chose to determine two schools from district 1, one school from district 2, and one school from district 3 as the comparison schools. In the two schools chosen as comparison schools in district one, all K-6 teachers were asked to respond to the survey, which created 14 teams of teachers in the comparison group. The number of MGC grade-level teams in districts 2 and 3 were fewer, so only one comparison school was asked to respond to the survey in those two school districts.

Socio-economic status as measured by the percentages of students qualifying for free and reduced lunch was also considered in determining the comparison group. The free and reduced lunch percentage for each school with a MGC teacher is presented in Table 3.1.

This table also includes the number of teachers participating in the survey from each school to show the composition of the MGC teacher groups and comparison groups. The eighteen lines are used to depict the eighteen MGC teachers included in the study and the members of their teaching teams. Some schools have more than one MGC teacher, so the percentage may be duplicated in the table in order to represent each team. The average percentage for MGC groups in each district was used in determining the schools chosen for the comparison group. For example, the average free and reduced lunch percentage for the schools included in district 3 was 49%, so a comparison school in district 3 with 53% free and reduced lunch percentage was chosen because it was the closest match within the school district to the MGC average of 49%.

Table 3.1

Study Participants – Socio-economic Status 2014- 2015

MGC group			Comparison group		
MGC Teacher School District	Free and reduced lunch percentage	Number of teachers on teaching team	School District	Free and reduced lunch percentage	Number of teachers
1	3	2			
1	19	2			
1	28	4			
1	30	3	1	36	18 (from 7 teaching teams)
1	30	2			
1	68	2			
1	78	3			
1	81	3			
1	82	2	1	80	11 (from 7 teaching teams)
1	88	4			
1	88	4			
2	30	3			
2	30	3	2	46	11 (from 5 teaching teams)
2	30	3			
3	44	3			
3	44	2			
3	55	4	3	53	17 (from 6 teaching teams)
3	55	3			
Total Teachers		52			57

* - Free and reduced lunch percentage data taken from Idaho State Department of Education School Report Card (Idaho State Department of Education, 2015) –

Instrumentation

An online survey administered online was used to gather data about teacher conversations regarding the frequency of mathematics during collaboration and the principal distributed leadership in the building. The survey had three sections and took respondents about ten minutes to complete. The survey was constructed and administered using Qualtrics software.

The first section of the survey asked respondents to answer general demographic questions such as years of teaching experience and grade level they are currently teaching. These questions were not used for a specific analysis in this study, but may be helpful for future analysis regarding the potential effects of grade level and/or experience on frequency of conversations.

The second section of the survey asked respondents to indicate how often they have conversations about specific topics such as student thinking in mathematics or lesson planning in their collaboration meetings. For example, they were asked "*how often they look at student work from a common task during collaborations"* and respond with one of the following options: never, *1-2 times per year, 1-2 times per semester, 1-2 times per month, 1-2 times per week, and 3 or more times per week*. These questions were been broken into two sub-sections; however, both sections are focused on specific activities and conversations occurring during collaboration. The two sub-sections were aligned to research about meaningful conversations in collaboration (Taylor, 2004; West, 2008) and the knowledge needed for teaching mathematics (Ball et al., 2001; Silverman & Thompson, 2008).

The third section of the survey included subsections of questions related to two different aspects of principal distributed leadership at the building level. The questions in the first subsection were about the building administrators' activities related to distributed leadership, and included items such as how often their principal provides meaningful feedback after an observation or provides support for collaboration meetings. The questions in the first subsection were answered on a frequency scale with the following options: never, 1-2 times/yr, 3-5 times/yr, 6-9 time/yr or 10+ times/yr. The questions in the second subsection focused on level of agreement of principal distributed leadership statements. The scale included the following five levels of agreement for each statement: (1) highly disagree, (2) disagree, (3) neither disagree nor agree, (4) agree, and (5) highly agree. The questions in the leadership section were aligned to the research on principal distributive leadership (Supovitz et al., 2009; Printy, 2010) and their ability to set expectations for continual growth and improvement in their building (Teague & Anfara, 2012).

The main content questions in the survey, which are included in the second and third sections of the survey were taken from a survey developed and administered by a group of professors at Boise State University. These questions were developed as a pilot survey after an extensive review of literature and crafted to address frequency of mathematics conversations during collaboration and about administrative leadership. The results of the pilot survey had high reliability among items in each section. The two scales in section two regarding frequency of conversations related to student thinking in mathematics were found to have high reliability (8 items, $\alpha = .95$; 9 items $\alpha = .964$). The scales in section three about the frequency of principal support were also shown to be highly reliable (11 items, $\alpha = .90$) as well as the items about the level of agreement with principal leadership (6 items, $\alpha = .92$).

Finally, two open-ended questions were included at the close of the survey to collect additional information about other potential professional development and allow teachers to share other thoughts related to the contents of the survey. The questions were: (1) Please list the mathematics professional development you have received over the past two years, and (2)

Any additional comments? The responses to these open-ended questions were used during data analysis to help create a better picture of the other possible influences to conversations occurring in collaboration about student thinking and instruction in mathematics.

Data Collection

Process and Organization

Data were collected through an online survey. The researcher chose to administer the survey online for time and cost efficiency. An online survey can also be convenient for respondents since they are able to complete the survey at a time that is most convenient for them (Dilman, Smyth, & Christian, 2009). One potential drawback of an online survey was the possibility of technical issues for respondents (Dilman, Smyth, & Christian, 2009); however, respondents had the link for the survey sent to their school district email and were able to respond at school, which may have helped in their access to a reliable network.

Before the survey could be distributed to teachers, it was necessary to contact a district level administrator in each school district to gain approval for distribution. This was done in a face-to-face meeting, so the purpose of the survey and intent of results could be explained to the district administrators while also allowing them the opportunity to ask questions or raise concerns. After gaining approval from district administration, the researcher contacted school principals to explain the purpose of the survey, so they were aware of its distribution to their teachers and would have an opportunity to voice any questions or concerns prior to administration of the survey to the teaching teams.

The survey was distributed via email, so it was necessary to compile a list of email addresses for the principals of each participating school so they could determine how they would like the survey distributed to their teachers and/or provide additional teacher email addresses. This was done through district contacts and through individual school and district websites. These lists are updated at the beginning of each school year, which assisted in the ability to compile an accurate list. The timing of the initial email to teachers was also scheduled to avoid any exceptionally busy times during the school year, such as parent-teacher conferences or testing periods. Carefully selecting a window for data collection can possibly help in gaining higher response rates (Dilman, Smyth, & Christian, 2009).

Distribution to Participants

The researcher worked with principals at each participating school to administer the survey. In some cases the principal chose to send the survey link and information to their teachers, and in other cases they chose to have the researcher send the information. In the cases where the principal distributed the survey email, the researcher visited the schools to deliver individual thank you notes to the teachers in an effort to make personal contact.

In many cases within the MGC group, the principal asked the MGC teacher to distribute the survey information to their team and arrange a time to meet with the researcher during collaboration. Two of the comparison schools also worked with the researcher to allow for personal visits with each team of teachers. With this coordination, the researcher was able to personally visit many teams of teachers during their collaboration meetings to provide necessary information for the survey along with the link to the online survey. During the visit, the researcher explained the background information, the purpose of the survey, intended use of the results, and privacy information. The visit allowed for the respondents to ask questions about their participation and voice any concerns before completing the survey. A survey link was provided to the teaching teams, so participants were able to respond at a time that is most convenient for them. Making personal contact with each potential respondent provided a personal connection and could have helped to improve the overall response rate (Dilman, Smyth, & Christian, 2009).

After gaining approval from principals and making contact with teaching teams, the researcher sent the survey link via email to respondents. Due to various response times from principals when gaining approval to distribute the survey to teaching and scheduling time to visit teams of teachers, the survey link took about three weeks to distribute to all of the respondents. The online survey was open for two weeks after initial contact had been made with all of the teaching teams (which allowed some comparison and MGC teams up to five weeks to respond). A few respondents had administrators provide time during their collaboration meetings to respond to the survey. All respondents without specific time set aside for the survey were sent two reminders via email to help increase the response rate (Dilman, Smyth, & Christian, 2009).

The survey link was distributed to 109 potential participants: 52 in the MGC group and 57 in the comparison group. Only complete responses were considered for analysis. The response rate for the MGC group was 96% (50 responses) and the response rate for the comparison group was 67% (38 responses), which provided 88 responses for analysis.

There was a possibility for the team of teachers to be unaware of the presence or absence of a MGC graduate on their grade level team. If the researcher were to specifically share this information with each team, it could have influence the results by creating a social threat to validity since the teachers may then have felt expected to respond in a particular manner (Donnelly & Trochim, 2007). Sharing this information could have also encouraged conversations in MGC teams that may not have occurred otherwise, which would have created bias in the results. To avoid having to share information with each team about the presence or absence of a MGC graduate prior to survey administration, two identical versions of the survey were created to send to the MGC group and the comparison group. Each group received a separate link to the online survey; however, the surveys were identical in every way. By sending each group a different link, the researcher did not need to include a question about whether or not a MGC teacher in on their teaching team which allowed the respondents in each group to have a blinded version of the survey.

The survey data for the MGC teacher groups and comparison groups were merged together after each survey had been closed. A nominal code was given to each group to indicate if they were initially in the MGC or comparison group prior to merging the data. All subsequent data analysis was completed with the combined set of responses.

Confidentiality

Names of some participants and email addresses were generated in cooperation with the participating school districts and/or principals, and used for initial contact, to send the survey information and for follow-up reminders. The researcher knew the names of some participants and which group they were included in for analysis, but was not able to identify individual responses since names were not collected through the survey. The study was approved by the University of Idaho Institutional Review Board before the researcher contacted participants or gathered any data. The approval process helped to ensure all efforts had been made to protect the confidentiality of research participants.

Data Analysis

The data were analyzed with several quantitative analyses including descriptive and inferential statistics. Before any inferential statistical analysis could be completed it was necessary to compute average conversation and leadership scores for each respondent. The

17 frequency conversation questions were coded with a value of 1-5, with 1 being the lowest frequency on the scale and 6 being the highest (1 = never, 2 = 1-2 times per year, 3 = 1-2 times per semester, 3 = 1-2 times per month, 4 = 1-2 times per week, and 5 = 3 or more times per week). These values for all 17 conversation questions were averaged to determine a mean conversation score for each respondent. The results of this analysis are presented in table 2.

Average scores were also computed for each leadership factor: leadership actions and leadership expectations. The 11 questions in factor related to leadership actions were responded to on a frequency scale. Responses were given a score of 1-5, with 1 being the lowest frequency and 5 being the highest (1 = never, 2 = 1-2 times/yr, 3 = 3-5 times/yr, 4 = 6-9 times/yr, and 5 = 10 or more times/yr). The scores on the 11 questions were then averaged to determine a mean score. The 6 questions in the factor related to leadership expectations were responded to with a Likert scale. Each response was given a score of 1-5 with 1 corresponding with highly disagree and 5 corresponding to highly agree (1 = highly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = highly agree). The results of this analysis are presented in table 3.2.

Table 3.2
Descriptive Statistics for Survey Scales

	Mean	Median	SD
Conversations (frequency scale/score 1-5)	4.08	4.21	0.95
Administrator Activities (frequency scale/score 1-5)	2.20	2.18	0.57
Administrator Expectations (Likert scale/score 1-5)	4.06	4.21	0.74

The results of the current survey were also determined to have high reliability among items in each section. The scale in section two regarding frequency of conversations related to student thinking in mathematics were found to have high reliability (17 items $\alpha = .966$). The scales in section three about the frequency administrator distributed leadership activities were also shown to be highly reliable (11 items, α = .81) as well as the items about the level of agreement with distributed leadership administrator expectations (6 items, α = .91).

Determining Groups Within Leadership Factors

After means scores were calculated for respondents in each leadership factor, the researcher needed to determine high and low groups to determine the difference in variance between high and low levels of perceived distributed leadership. Frequency distributions were used to examine the spread of data and assist in determining cut scores for each group. A smaller, mid range group was removed in the administrator activities dataset to assist in making the high and low groups more distinct. All 88 responses in the dataset were used when determining the groups for each leadership factor.

The average scores for the leadership activities factor ranged from 1.09 to 3.45. The data seemed to split around the mean, so group were determined as follows: high 2.31+ (39 respondents), mid 2.01 – 2.30 (12 respondents), and low 1.09 – 2.0 (37 respondents). The division of groups also seemed to fit with the response scales for this set of questions. The highest average score (2.0) for the low group aligns with an average frequency of 1-2 times per year for each administrator activity. The lowest average score for the high group (2.36) indicates a higher frequency on just over a third of the items (4 items). The mid range group was removed so only the subset of high and low groups remained for further leadership activities analysis. The frequency data used to determine leadership activities groups in included below in table 3.3.

Table 3.3

Frequencies and groups – Administrator Activities

Mean	Frequency	Percentage	Group
1.09	1	1.0	L
1.27	5	5.0	L
1.36	2	2.0	L
1.45	3	3.0	L
1.55	3	3.0	L
1.64	8	7.9	L
1.82	4	4.0	L
1.91	7	6.9	L
2.00	4	4.0	L
2.09	5	5.0	M
2.18	3	3.0	M
2.27	3	3.0	M
2.30	1	1.0	M
2.36	8	7.9	H
2.45	6	5.9	H
2.55	5	5.0	H
2.64	2	2.0	H
2.73	2	2.0	H
2.82	3	3.0	H
2.91	2	2.0	H
3.00	4	4.0	H
3.09	1	1.0	H
3.18	1	1.0	H
3.27	4	4.0	H
3.45	1	1.0	H

The average scores for leadership expectations ranged from 1.67 to 5.0, but were skewed in the positive direction. The distribution was used to determine high and low groups. The low group average scores ranged from 1.67 – 3.99 and included 30 respondents, and the high group's average scores ranged from 4.0 – 5 and included 58 respondents. Even though this created different sized groups, the groups were split in this way to align with their average responses on the Likert scale. An average score of 4 and above would indicate an average response of agree or highly agree. A score less than 4 would indicate an average response of neither agree nor disagree, disagree or highly disagree. Therefore the two groups are split by whether or not their average score agreed with statements or not. The frequency data used to determine leadership expectation groups is included below in table 3.4.

Table 3.4

Frequencies and groups – Administrator Expectations

Mean	Frequency	Percentage	Group
1.67	1	1.0	L
2.00	1	1.0	L
2.33	1	1.0	L
2.50	2	2.0	L
2.67	1	1.0	L
3.00	3	3.0	L
3.17	1	1.0	L
3.33	2	2.0	L
3.50	9	8.9	L
3.67	5	5.0	L
3.83	5	5.0	L
4.00	13	12.9	H
4.17	4	4.0	H
4.33	10	9.9	H
4.50	6	5.9	H
4.67	8	7.9	H
4.83	2	2.0	H
5.00	14	13.9	H

After mean conversation and leadership scores were computed and high and low groups were created for the distributed leadership scales, factorial design utilizing a 2x2 ANOVA was used to address all three research questions. The factorial design allowed the researcher to look at the levels created within both factors and analyze the variance among the groups created by the combination of the two factors (Privitera, 2015). In order to examine the influence of each distributed leadership subscale, the researcher performed two different factorial ANOVA analyses. The first analysis was to examine was the presence or absence of a MGC teacher and the presence of high/low distributed leadership administrator activities. The second analysis was to examine the presence or absence of a MGC teacher and the presence of high/low distributed leadership administrator expectations. The scores for frequency of mathematics conversations were the outcome variable for each analysis when investigating the comparison between the two groups created by each factor.

Including both factors in the 2x2 factorial design created four groups (MGC/high distributed leadership, MGC/low distributed leadership, comparison/high distributed leadership and comparison/low distributed leadership) and allowed the researcher to determine the potential influence of having both the presence of a MGC teacher and high distributed leadership compared to having only MGC or high distributed leadership. The 2x2 ANOVA allowed for the analysis of the interaction of the two factors, which enabled the researcher to determine if having both elements created a significant influence on the frequency of teacher conversations. The design analysis is included in the figure 3.1 below.

		Distributed Leadership Administrator Activities/Expectations	
		High	Low
Knowledge	MGC		
	Comparison		

Figure 3.1. 2x2 Factorial Design

Summary

This study was a quantitative, non-experimental group comparison utilizing survey research methods to analyze the potential influence of teacher knowledge in mathematics and principal administrative leadership on the frequency of conversations related to student thinking and instruction in mathematics. The sample for the study consisted of two groups of teaching teams currently teaching in elementary schools in the Pacific Northwest. The two groups were determined by the presence or absence of a MGC teacher on their teaching team. The data for the study was obtained through one survey administered to all teachers in the study. The survey had two major content sections asking about the frequency of conversations related to mathematics instruction and the frequency of principal involvement in activities related to conversations occurring during collaboration. A 2x2 factorial ANOVA was used to determine potential differences in groups and the degree of influence a teacher’s increased knowledge in teaching mathematics (MGC) and the distributed leadership have on the frequency of conversations related to mathematics instruction.

Chapter Four: Results

Chapter four addresses the survey results regarding the influence of (1) the presence of a teacher with increased knowledge in mathematics and (2) the presence of distributed leadership on the frequency of conversations about student thinking and instruction in mathematics. This chapter will address the analyses in relation to all three research questions along with follow-up analyses based on additional findings determined through survey results.

Factorial ANOVA Analyses

Checking Assumptions prior to ANOVA Analyses

Prior to conducting the analysis of variance between groups it was necessary to check for assumptions within the data to be used in each analysis. Independence of groups is true for each group within the data because each respondent falls within one subgroup for each analysis. For example, in the dataset used to analyze the relationship between administrator actions and increased teacher specialized content knowledge, each respondent falls into one unique subcategory: (1) high administrator actions/MGC, (2) high administrator actions/comparison, (3) low administrator actions/MGC or, (4) low administrator actions/comparison. The same situation is true for the dataset used for analyzing the relationship between administrator expectations and increased teacher specialized content knowledge.

Levene's test for equality of variances was used with each dataset to determine homogeneity of variance. The results of this test with dataset used to analyze the relationship between administrator actions and increased teacher specialized content knowledge were not significant ($F = 1.40$, $p > .05$), which indicates a similar variance in each group. The results of the test with the dataset used to analyze the relationship between administrator expectations and increased teacher specialized content knowledge were also not significant ($F = 0.97$, $p > 0.5$), which demonstrates a similar variance within groups in the second dataset.

Normality for each subgroup was checked through examining measures of central tendency and histograms. Each group within the two datasets (administrator actions dataset and administrator expectations dataset) appeared to be normally distributed. The descriptive statistics for each data set are included with the ANOVA results in tables 5 and 6.

2 x 2 Factorial ANOVA Analyses

A 2 (teacher specialized knowledge) X 2 (leadership activities) between subjects factorial ANOVA was calculated comparing the increased teacher specialized content knowledge in mathematics (MGC teacher on the team or comparison group without MGC teacher) and the frequency of distributed leadership activities (high/low) on the frequency of conversations about student thinking and instruction in mathematics. The main effect for increased teacher specialized knowledge was not significant ($F(1,71) = 3.57$, $MS_e = .90$ $p > .05$). Then main effect for distributed leadership administrator activities was also not significant ($F(1,71) = 1.02$, $MS_e = .90$, $p > .05$). Finally, the interaction was not significant ($F(1,71) = 3.16$, $MS_e = .90$, $p > .05$). Thus it appears that neither teacher specialized knowledge nor distributed leadership administrator activities have a significant effect on frequency of conversations about student thinking and instruction in mathematics. The results of this analysis are presented in table 4.1.

Table 4.1

2x2 Factorial ANOVA: Knowledge x Administrator Activities

Factor		M	SD	F	pValue
Increased Teacher Knowledge				3.57	.06
	MGC	4.16	1.04		
	Comparison	3.75	.98		
Administrator Activities				1.02	.32
	High	4.12	.86		
	Low	3.85	1.08		
Knowledge x Admin Activities				3.16	.08
MGC	High Admin. Act. (21)	4.48	.82		
	Low Admin. Act. (22)	3.86	1.14		
Comparison	High Admin. Act. (17)	3.67	.70		
	Low Admin. Act. (15)	3.84	1.03		

p value is significant at $p<0.05$

A second 2 (teacher specialized knowledge) X 2 (leadership expectations) between subjects factorial ANOVA was calculated comparing the increased teacher specialized content knowledge in mathematics (MGC teacher on the team or comparison group with out MGC teacher) and the frequency of distributed leadership expectations (high/low) on the frequency of conversations about student thinking and instruction in mathematics. The groups created by the two factors in the analysis were unequal, however, ANOVA is resilient to slightly different sample sizes, so adjustments prior to analysis were not necessary (Games, 1972). The main effect for increased teacher specialized knowledge was not significant ($F(1,84) = 0.48$, $MS_e = .85$, $p > .05$). Then main effect for distributed leadership administrator expectations was also not significant ($F(1,84) = 2.45$, $MS_e = .85$, $p > .05$). However, the interaction was significant ($F(1,84) = 4.35$, $MS_e = .85$, $p < .05$). Thus it appears that neither the teacher specialized knowledge nor distributed leadership administrator expectations by themselves have a significant effect on frequency of conversations about student thinking and instruction in mathematics, but the interaction of the two factors does create a significant effect. The results of this analysis are presented below in table 4.2.

Table 4.2

2x2 Factorial ANOVA: Knowledge x Administrator Expectations

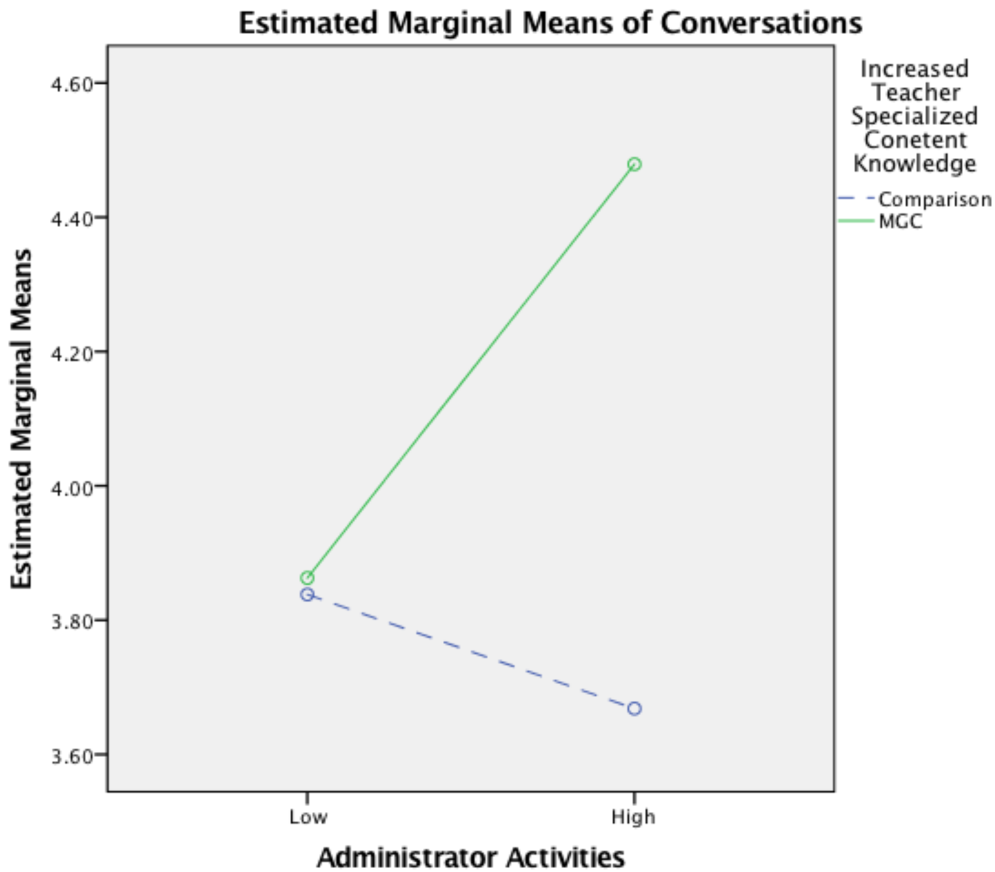
Factor		M	SD	F	pValue
Increased Teacher Knowledge				.48	.49
	MGC	4.23	.99		
	Comparison	3.84	.88		
Administrator Expectations				2.45	.12
	High	4.23	.86		
	Low	3.90	1.09		
Knowledge x Admin Activities				3.69	.04*
MGC	High Expectations (35)	4.45	.84		
	Low Expectations (15)	3.69	1.13		
Comparison	High Expectations (23)	3.87	.79		
	Low Expectations (15)	3.98	1.06		

p value is significant at $p<0.05$

Graphs were generated to further depict the relationship between the distributed leadership scales and the increase in teacher specialized content knowledge. Different lines were used to show the variance between mean conversations scores with the MGC teacher groups and comparison groups with the presence of high and low distributed leadership. The graph in figure 4.1 shows the difference in mean conversation scores with high and low distributed leadership administrator activities. While this difference is not significant, the visual analysis allowed for the researcher to see an increasing trend in conversations scores with the MGC group with the presence of high distributed leadership activities.

Figure 4.1

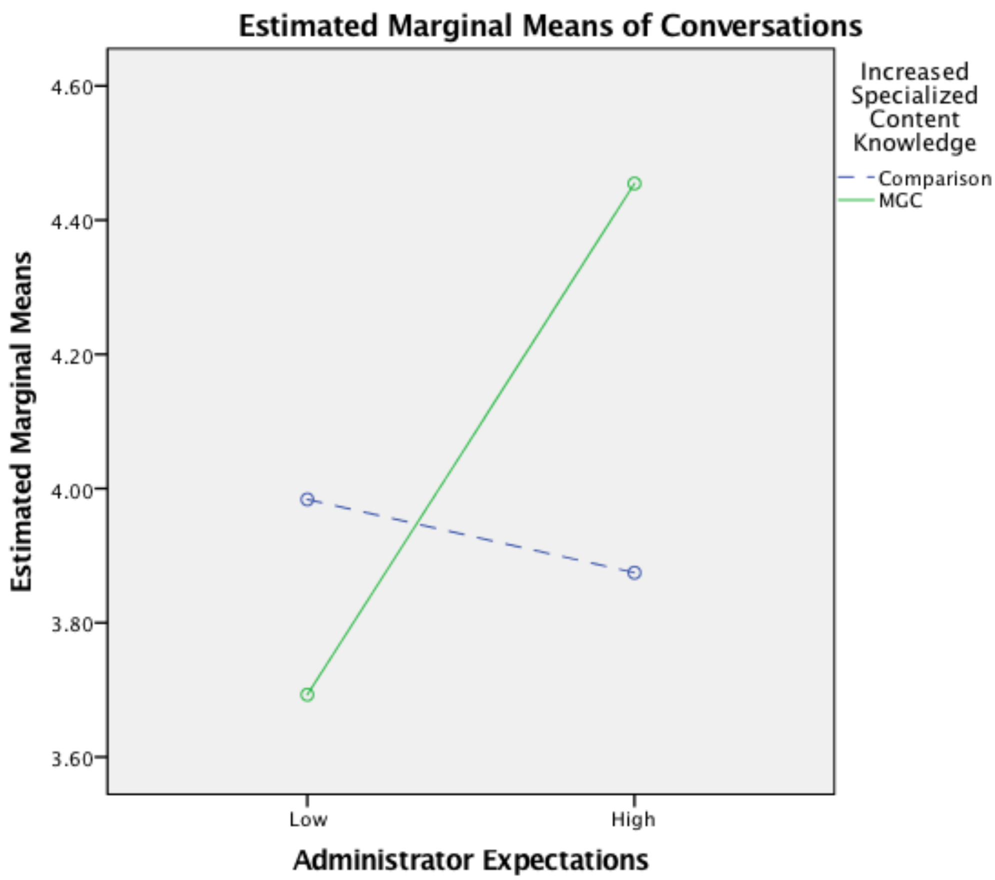
Mean Conversation Scores for Increased Teacher Specialized Content Knowledge x Distributed Leadership Administrator Actions



A second graph was generated to visually analyze the relationship between the increase in specialized teacher content knowledge and the distributed leadership administrator expectations. The graph demonstrates the significant increase in mean conversation scores with the MGC group with the presence of higher distributed leadership administrator expectations. The graph also shows a slightly lower mean conversation score in the comparison group with the presence of high distributed leadership administrator expectations. The intersection of the two lines helps to demonstrate the significant interaction between the two factors. The graph in figure 4.2 displays the relationship between these factors as related to teachers' conversations about student thinking and instruction in mathematics.

Figure 4.2

Mean Conversation scores for Increased Teacher Specialized Content Knowledge x Distributed Leadership Administrator Expectations



Question 1

Does the presence of a MGC teacher influence the frequency of conversation about student thinking and instruction in mathematics?

Based on the results from the ANOVA analyses discussed above, it appears the presence of a teacher with increased specialized content knowledge alone does not significantly influence the frequency of conversations related to student thinking and instruction in mathematics. Therefore the null hypothesis is accepted for the first research question.

Question 2

Does the level of principal's distributed leadership at the building level influence the frequency of conversations about student thinking and instruction in mathematics?

Two elements of distributed leadership (activities and expectations) were analyzed using an ANOVA. The results from each analysis indicate that the level (high/low) of distributed leadership activities and distributed leadership expectations alone do not significantly influence the frequency of conversations related to student thinking and instruction in mathematics. Therefore the null hypothesis is accepted for the second research question.

Question 3

Does the presence of a MGC teacher and the presence of principal distributed leadership have additional influence on the frequency of conversations about student thinking and instruction in mathematics than one factor has on its own?

The third research question regarding the combined influence of increased teacher specialized content knowledge and level of distributed leadership was analyzed using the 2x2 factorial ANOVAs described above. Based on the results of the ANOVA analysis it seems there is no significant effect with the interaction between teacher specialized content knowledge and distributed leadership administrator activities. However, the analysis did indicate a significant interaction between high teacher specialized content knowledge and the level of distributed leadership administrator expectations. Therefore, the null hypothesis is retained for the third research question.

Follow-up Analyses

Simple Effect Tests to Analyze Significant Interaction

After the factorial ANOVA showed a significant interaction between knowledge and administrator expectations, it was necessary to perform simple effect tests to determine where the interaction existed. A one-way between subjects ANOVA was performed between all four groups to determine the significant interaction. The results of these analyses showed no significant difference between the MGC teacher group and comparison group, no significant difference between the high and low distributed leadership administrator expectations groups, and no significant difference between the MGC teacher group and comparison group with presence of low distributed leadership. The results of the simple effects test between the MGC teacher group and comparison group with the presence of high administrator expectations ($F = 5.50$) showed a significant difference at $p < .05$, but after the Bonferroni adjustment to $p < .0125$ the interaction was no longer significant.

Quantitative Analysis of open-ended questions

Two open-ended questions were included at the end of the survey to gather data on potential additional influences to survey results. The first question was “Please list the mathematics professional development you have received over the past 2 years”. Many respondents included several different types of professional development in their response to this question. In order to analyze the responses, the researcher looked for commonalities among types of professional development and coded each response to correlate with the types of professional development included in their response. This meant that several responses were counted in more than one type of professional development. For example, a response of “MTI training, district meeting/training as the math rep. for 2nd grade” would be coded under ‘MTI course’ and ‘School district workshop/trainings’. The responses in each category were then counted to gather a sense of additional potential factors contributing to frequency of conversations related to student thinking and instruction in mathematics. From the numbers presented by the data it appears that school district professional development was a large part of the professional development provided to the respondents. The results of this analysis are included in table 4.3.

Table 4.3

Responses to open-ended survey question: Please list the mathematics professional development you have received over the past 2 years.

Category of Professional Development (PD)	Number of responses*	Description
MTI course	23	Specific mention of recently taking the MTI course
MGC program	14	Specific mention of taking all or some of the courses in the MGC program
University workshop / support	18	Comments include workshops or other professional development offered through university programs or partnerships
School District workshops / trainings	42	Respondents listed workshops or trainings offered through their school district – including professional development provided by district coaches
Conferences	3	Specific mention of state or national conferences
Curriculum development / piloting	12	Respondents include involvement in piloting a specific curriculum as part of their recent professional development
None	2	none

*respondents may have mentioned PD occurring in more than one category

The second open-ended question was, “Any additional comments?” This question received only 13 responses, which are summarized below. The researcher looked through the comments to find themes in these additional comments and found three common themes: comments related to professional development, comments related to standards or instruction, and comments about the respondent's school or district administration. Examples and frequencies for these types of responses are included below in table 4.4.

Table 4.4

Responses to open-ended survey question: Any additional comments?

Type of response	Number of responses	Description
Professional development comment	4	Respondents comments include recommendations or concerns about professional development opportunities
Standards or instruction comment	6	Comments are related to teaching with CCSS-M and/or how instruction in mathematics has changed with professional development or implementation of CCSS
District or school comment	3	Respondents comments are related to a school or district issue or focus

Summary

Chapter four presented the results from the analysis of the survey conducted to address the three research questions relating to the frequency of conversations about student thinking and instruction in mathematics with the influence of (1) increase in teacher specialized content knowledge and (2) administrators demonstrating distributed leadership actions and expectations. The findings did indicate that there was a significant interaction between increased teacher specialized content knowledge and distributed leadership administrator expectations and the frequency of conversations about student thinking and instruction in mathematics. However there was no significant relationship between one of the factors alone, or in the interaction between increased knowledge and administrator activities and the frequency of conversations. Chapter five will provide a detailed discussion of these results with connections to the literature and recommendations for future research based on the results of this study.

Chapter Five: Discussion

This study was designed to examine the influence of teacher specialized content knowledge and distributed leadership on the frequency of conversations about student thinking and instruction in mathematics. The study focused on a specific graduate level program at a local university to identify teachers who have demonstrated an increased level of specialized content knowledge. An online survey was used to collect data on the frequency of conversations about student thinking and instruction in mathematics and administrator activities and expectations related to distributed leadership. The results of this study indicate that there is a significant interaction between the increase in specialized content knowledge and distributed leadership administrator expectations on the frequency of conversations about student thinking and instruction in mathematics. However, tests of simple effects after finding the significant interaction ed the interaction did not quite reach significance. While the analyses significance in one area, a trend towards athe frequency of conversations with the presence of a MGC teacher and higher levels of distributed leadership, which is encouraging for both the present and future studies. This chapter will provide a detailed synthesis of the findings from this study along with its connections to existing literature and implications for future research.

Summary of Findings

The first analysis examined the factors of specialized content knowledge (MGC/comparison groups) and distributed leadership administrator activities no significant difference with the presence of increased teacher knowledge and/or administrator distributed leadership. In this analysis, both the main effects and the interaction were not significant. However, examination of the trends in figure 4.1 indicates strong support for the importance of high distributed leadership activities with the presence of teachers with increased specialized content knowledge The graph demonstrates the relationship between these two factors the discrepancy between mean conversation scores between the MGC teacher group comparison group with the presence of high administrator activities.

In the second factorial ANOVA the factors of teacher specialized content knowledge and distributed leadership administrator expectations. This analysis ed a significant interaction between the two factors on the frequency of conversations about student thinking and instruction in mathematics. While the interaction was significant in the factorial ANOVA analysis, the tests of simple effects the interaction each significance.   the limited sample size did not allow the interaction to after follow-up tests the trend the data between these two factors.

To help with interpretation of the results, the researcher also generated graphs of the mean conversation scores for the MGC teacher group and comparison group with the presence of high and low distributed leadership. The graphs that a higher level of administrator activities and expectations are related to a higher frequency of conversations about student thinking and instruction in mathematics with the MGC group. The comparison group had little difference in frequency with the difference in leadership scores. While these increases in conversation scores were not significant for the administrator scales, they trend toward MGC teachers having an influence on the conversations occurring when higher levels of both distributed leadership activities and expectations are present.

Conclusions

Significant results were found in the interaction between increased level of teacher specialized content knowledge and distributed leadership administrator expectations.

However, the simple effects test ed the interaction after the Bonferroni adjustment was made. This inconsistency is possibly due to the small sample size (N=88). While these results , the trends in the data provide initial support for the importance of teachers gaining an increased level of knowledge returning to a building where administrators support them in becoming teacher leaders, which allows them to share their knowledge with their grade level teams through conversations during collaboration.

While significant findings are desired, the analysis of can help provide information to inform future research. For this reason, further the results is necessary. Discussion of the findings related to each factor is included below along with discussion about the potential influence of the combination of the two factors. Information about external and circumstantial factors provided by free response questions included in the survey are also discussed.

Distributed Leadership Administrator Activities and Expectations

Principals have the opportunity to influence the values and focus within their school through both the activities they engage in and the expectations they set for their teachers. The expectations and focus within the building can also help create a sense of shared leadership where teachers feel empowered to take on leadership roles and provide support to their peers (Supovitz, Sirinides, & May, 2009). The results of the current study help to provide initial support for the importance of the distributed leadership activities and expectations of administrators.

Neither of the distributed leadership factors alone ed a significant effect on the frequency of conversations about student thinking and instruction in mathematics. The lack of significance (activities $p = .32$, expectations $p = .12$) may indicate that leadership alone may not be enough to influence conversations. A higher level of distributed leadership activities and expectations did not have the same positive influence on the mean conversations scores in each group. These results suggest the need for high distributed leadership to be coupled with other factors such as knowledge to influence conversations.

The mean conversation scores for each leadership scale were higher with the presence of high distributed leadership activities and expectations. The difference in mean scores could suggest a trend toward the positive influence a principal with a distributed leadership perspective is able to have on the conversations occurring during collaboration. However, since these findings were not significant, it was important for the researcher to look for additional insight from the open-ended questions in the survey that asked respondents to share any additional comments or thoughts about the topics addressed in the survey.

Some comments made by teachers display a need to look at district leadership when considering the potential influence of leadership on the frequency of conversations. One respondent commented about how they felt their school district was not supportive of math coaches. The lack of district support for teacher leadership may be difficult for a teacher with increased knowledge to feel empowered to share their knowledge with their peers. Another respondent commented about their desire to attend more professional development for mathematics, but the number of other required trainings made it difficult for this to happen. The comment may point towards a potential lack of focus on mathematics within at least one of the participating districts, which could have impacted the frequency of conversations among grade level teams.

The literature on distributed leadership points towards the need for principals to set the tone and focus for their school, and the chosen focus can help or hinder progress in particular subject areas. The direction of the school focus seemed to influence one respondent in the MGC group, and they commented about how mathematics was not a focus in their school. The comment demonstrates how the school focus can hinder the frequency of conversations occurring during collaboration meetings on student thinking and instruction in mathematics. A school environment where mathematics was not a focus could make it difficult for a teacher with increased knowledge in mathematics to share with their peers.

The comments made by respondents also indicated a link between high levels of distributed leadership and the frequency of conversations related to student thinking and instruction in mathematics. When asked about any additional comments at the end of the survey, one respondent from the comparison group discussed how they held their administrators in high regard and felt they worked to keep the school focused on best practices in their teaching. The comment on administrator support aligned with the respondent having high distributed leadership means on both leadership scales in the survey. The comment, along with the scores on the leadership scales, aligns with Heck and Hallinger's (2009) findings about the potential of school leadership and capacity building being dependent on one another. Their study highlighted the need to distribute leadership tasks such as sustaining a focus on academic improvement and developing instruction and the comment made by this respondent provides further support for this idea.

Teachers Gaining Specialized Content Knowledge in Mathematics

Many studies have demonstrated the need for teachers to have specialized content knowledge in mathematics in order to help students build a depth of understanding and flexibility in mathematics (Silverman & Thompson, 2008; Ball, Hill, & Bass, 2005). This knowledge can influence not only the quality of instruction in the classroom, but also the types of conversations teachers are able to have with their peers during collaboration (Slavit et al., 2013). Gains in specialized content knowledge can come from various places, one of which is professional development.

In both datasets utilized for analysis, the MGC group had higher mean conversation scores than the comparison group. While most of the same participants were used in each dataset, it is reassuring to see the high mean holds as the set was slightly adjusted to fit the high and low leadership factors. Further, the factorial ANOVA analysis with administrator activities produced a p value approaching significance between the MGC teacher group and comparison group ($p = 0.06$). While this value is not significant, it does indicate the data leaning towards greater mathematics knowledge having a positive influence on the frequency of conversations. The value demonstrates strong trends towards the importance of having teachers with increased specialized content knowledge on elementary teaching teams to help influence the frequency of conversations about student thinking and instruction in mathematics. A larger sample size may have been able to demonstrate a significant difference with the factor of knowledge.

The trends in the data support the findings of Slavit et. al (2013) when they discussed how teachers with higher levels of knowledge are able to help facilitate more in depth conversations during collaboration. They highlighted how the ability to discuss what is or is not present in student work is connected to teacher content knowledge, and the focus on student thinking during collaboration can help make these meetings more productive. The results of the current study demonstrate the importance of having a teacher with increased specialized content knowledge present during collaboration to increase the frequency of conversations about student thinking in mathematics.

However, since the findings for the increase in teacher specialized content knowledge were not significant, it was important for the researcher to look for further explanation for the findings in the open ended questions within the survey. Recognizing there may be other influences on the increase of teacher specialized content knowledge outside of the program used in the study, the research included an open-ended question at the end of the survey to ask about the types of professional development the respondents had been involved in over the past two years. This information provides some insight into the additional professional development influences and the struggle to isolate the influence of one particular program such as the MGC program used in the study.

Many teachers responded to the question about professional development by highlighting the in-district sessions they had attended over the past two years. Teacher comments about district supported professional development included general comments about professional development days set aside by the school district, while others provided names of specific district workshops. Since these professional development opportunities were afforded to all teachers within the school district it could make it more difficult to tease out the influence of only the MGC graduate program.

Respondents also listed attending workshops and trainings outside of their school district, which further complicates the task of isolating the influence of the MGC graduate program. Some respondents commented on attending various local and national conferences, while others commented on workshops provided by local universities. A respondent in the MGC group commented on several specific university workshops they had attended during the current school year. Further, 20 respondents specifically mentioned taking the state required MTI class within the past two years. As previously mentioned, the class is built from the same research base and framework as the MGC program and is often the course that sparks an interest for teachers to participate in the MGC program. Therefore, knowing most respondents in the study have taken the MTI class, and at least 20 respondents had recently taken the course, it may have influenced frequency of conversations related to student thinking and instruction in mathematics in each group.

Other respondents answered the questions about additional professional development by discussing their involvement in piloting curricular materials. While piloting materials may or may not be considered professional development, the teacher's involvement in these pilots may have influenced the conversations occurring during collaboration meetings. The pilots could shift the focus of conversations towards specific lessons or discussion of particular materials and away from discussions focused on student thinking. Alternatively, if the curricular materials in the pilot emphasize a focus on student thinking and the shifts required by the CCSS-M, it could influence an increase in the frequency of conversation related to student thinking and instruction in mathematics. Examples such as this provide further evidence of the other external professional development afforded to the teachers in the study.

Even with all of the other external influences on the increase of teacher specialized content knowledge it is still important to look at the potential impact a MGC teacher can have on the conversations occurring within their grade-level team. The results of this study seem to indicate the presence of a teacher with increased specialized content knowledge can have a positive influence on the frequency of conversations about student thinking and instruction in mathematics. The potential for this positive influence is supported by the results of the factorial ANOVA in table 4.1 which show a *p* value of .06 as the main effect for teacher knowledge.

Distributed Leadership and Teachers Gaining Specialized Knowledge

In their framework for distributed leadership, Spillane et al. (2004) discussed the need for administrators to involve others in leadership by allowing informal leaders to share in leadership tasks and positions. The framework creates a model that focuses on allowing the faculty of a school to grow together by utilizing the resources available to them in their school, including resources such as knowledge. The results of the factorial ANOVA analyses provides emerging support for the importance of administrators to take on a distributed leadership perspective and allow teachers with increased content knowledge to influence the conversations occurring within their grade level teams. The results of the interaction between the distributed leadership scales and MGC/comparison groups were either significant (expectations $p = .04$) or leaning towards ing significance (activities $p = .06$). The results of the analyses help to create a need for further investigation into the relationship between these two variables on the frequency of conversations occurring about student thinking and instruction in mathematics.

Numerski (2013) explored the need to focus on how various leadership roles within a school work together. She highlighted the importance of beginning to integrate the literature on various leadership roles within a school to create a narrative of how they work together to improve instruction. The results of this study provide initial evidence of the potential differences that can occur in conversations when both teacher leaders with increased specialized content knowledge and high levels of distributed leadership administrator expectations are present. While not significant, the results of the interaction of knowledge and administrator actions and expectations provide some initial evidence of these differences. The graphs of the mean conversation scores provide support for the need to further investigate how the various leadership roles within a school can collectively work together. These results begin to create the type of conversation Numerski (2013) called for in her article by demonstrating how formal and informal leadership roles can support one another in an elementary school setting.

The mean conversations scores for the MGC teacher group and comparison group are similar with the presence of low distributed leadership administrator activities and expectations. However, when high levels of distributed leadership administrator activities and expectations are present, there is a larger increase in mean scores in the MGC group. The differences in mean scores within each group help to support the importance of distributed leadership in fostering the spread of knowledge by supporting informal leadership roles such as MGC teachers. The difference in scores with the presence of high distributed leadership activities and expectations align with Goddard et al. (2015), who also discussed the important role administrators play in helping to facilitate high levels of collaboration within a school.

Further, the graphs help to better understand the significance of the interaction between increased knowledge and administrator expectations. The intersection of the two lines creates a visualization of the significant interaction between these two factors. While neither of the factors were significant alone, the interaction of the two creates an interesting story. The MGC group has higher mean frequency of conversation scores with the influence of high distributed leadership activities and expectations. However, the comparison group actually has lower mean frequency of conversation scores with the presence of high distributed leadership activities and expectations. The difference in scores with the presence of high distributed leadership speaks to the need for both factors, high distributed leadership and increased specialized content knowledge, to be present in order to see a higher mean frequency of conversation score during collaboration.

While the results of the significance interaction are inconsistent, they provide initial support for the ability of distributed leadership within a school to help in supporting the emergence of teacher leaders with increased specialized content knowledge. These results further validate Kennedy et al.'s (2011) recommendation for creating a culture of shared leadership within a school to help build a shared vision, which includes allowing teachers to take on leadership roles. These leadership roles can include teachers with increased specialized content knowledge feeling empowered to share their knowledge with their grade level teams during collaboration meetings.

Limitations

This study has several limitations. The small sample size used in the study limits not only the results, but also the ability to generalize to other populations. Since the researcher chose to operationalize the increase in teacher specialized content knowledge through teachers who had completed at least 6 of the 7 courses required for the MGC graduate certificate, the available population was limited since the program is still in its first five years. The first course in the program is the MTI course, which is currently required by the state of Idaho for teacher recertification, so most of the teacher in the study have taken at least this one course. This slight overlap may have created a challenge with the comparison group. The small population (88 respondents) used in the analysis also makes the results difficult to generalize since the numbers are still small enough to be impacted in either direction by only a few more responses.

The sample chosen for this study was purposeful and therefore not randomly selected from a larger group. Thus, the sample used in the study makes it difficult to generalize results to other populations. Changing the sampling methods could have produced different results, but would have made it more challenging to hone in on a specific program used to increase teacher specialized content knowledge in mathematics.

The sample for this study included teachers who had completed or almost completed the MGC program. Since the program has a focus on building teacher leaders, it was assumed the teachers in the study had an interest in sharing the knowledge they gained in the program with other teachers. This assumption may have created another limitation for the study since it is likely for teachers to enter the program with the sole interest of gaining more knowledge to become a better teacher without an interest in sharing what they had learned.

Another limitation is in the lower response rate of the comparison group. The MGC group had a very high response rate (98%) while only two-thirds of the comparison group responded to the survey. The difference in response rate may indicate bias in the results as the teachers who chose not to respond in the comparison group may have done so for various reasons such as lack of interest the topic or concern about providing responses related to their building principal. The researcher was also not able to make an in-person visit to all of the comparison schools due to school scheduling conflicts, so even though the researcher delivered a thank you note to each teacher and sent several reminders, the lack of in-person contact may have influenced the response rate for some schools within the comparison group.

Implications for Practice

The results of this study demonstrate a trend towards the positive influence teachers with specialized content knowledge can have on their peers with the presence of high distributed leadership administrator expectations. For this reason, school districts and administrators may consider focusing on distributed leadership activities and expectations to help build capacity within their schools and help foster teacher leaders to assist in shifting instruction to better address the CCSS-M.

However in order to allow for teachers with specialized knowledge to influence their peers, schools and districts need to ensure they are creating and protecting systems to support teacher collaboration. Specific time should be set aside for teachers to work together and learn from each other. Penuel et al. (2006) discussed how teachers were more likely to make change when they were able to work with a peer who had already begun making the change. Therefore, the structure of collaboration time set aside by districts could include teachers having the chance to watch each other in the classroom, which could provide more opportunities for teachers to have discussions about student thinking and instruction in mathematics due to the shared experiences.

Reflection on University Programs

The results of this study also provide useful information for university programs seeking to create administrators with a focus on shared leadership and teacher leaders with increased specialized content knowledge. The study helps to highlight the importance of administrators focusing on the collaborative leadership standards within the Idaho Foundation Standards for School Administrators. The collaborative leadership standards align with the ideas of distributed leadership and focus on administrators encouraging teachers to be a part of the leadership process (Idaho State Department of Education, 2014). When teachers with increased specialized content knowledge are a part of the leadership process they can feel empowered and supported as they try to influence their peers to make instructional changes. Educational Leadership programs within universities could use this information to help future administrators better understand the importance of collaborative leadership and how it can be used to build capacity for growth within schools and districts.

Graduate programs designed to help teachers build specialized knowledge can also utilize the results of this study to inform the structure and focus of their courses. While the findings were not significant, they do indicate a trend towards the positive influence of teachers with increased specialized content knowledge. The challenge is helping these teachers with increased knowledge feel empowered to share this knowledge with their peers, and providing them the tools to do this effectively. University programs seeking to create teacher leaders with increased specialized content knowledge may consider infusing leadership elements into each course to help these teachers feel prepared to share their knowledge as they leave the program.

The MGC program is currently undergoing changes to differentiate between teachers who would like to become teacher leaders and teachers who enter the program with the sole purpose of gaining more knowledge to become a better teacher. By creating two pathways it will allow for the teacher leader path to have an increased focus on leadership, which may increase teacher preparedness and ability to influence change in others. The other pathway would build specialized content knowledge and an understanding of student thinking without the leadership focus. By replicating this study in the future with teachers who have chosen the leadership pathway it would eliminate the limitation of teachers not having the desire to share knowledge and may make it easier to determine the influence of these teacher leaders.

Implications for Future Research

This study provides a conceptual model and methodology for thinking about the potential influence of increased teacher specialized content knowledge and distributed leadership on the frequency of conversations about student thinking and instruction in mathematics. Other researchers may find the framework to be a useful way to think about the combined influence of these two factors on teacher conversations in collaboration because it address the interaction of teachers, teachers leaders and administrators.

Further research around the significant interaction between increased teacher specialized content knowledge and distributed leadership administrator expectations would be helpful in determining if the results from this initial study hold for other or larger populations. While the significant results are promising, the inconsistency and limitations of study make it difficult to generalize to other situations or populations, so additional research would help in further investigating this relationship.

The results of this study are encouraging and create opportunities for further research. Provided the limitation regarding the number of graduates, this study could be replicated once more teachers have been able to go through the MGC program. A follow-up study would allow the researcher to gain a larger sample while also including other school districts. Beyond the specific professional development program used in this study, other mathematics professional development programs could use the same design and survey instrument to further investigate the potential influence of increased knowledge and distributed leadership on teacher conversations. The study methodology could also be utilized for investigating an increase in other content areas by using a different set of questions in the conversation factor and operationalizing gains in content knowledge with a different content area professional development program.

The research has implications for further studies on the influence of distributed leadership on the development of teacher leaders and the conversations occurring during collaboration. Distributed leadership is only one lens with which we can examine leadership. Other leadership perspectives could be integrated into this model and tested to determine their potential influence on teacher collaborative conversations and/or their influence with the interaction of increased teacher specialized content knowledge. Further research could also delve further into specific practices of distributed leadership to highlight the ways in which tasks are enacted within schools to support the presence of teacher leadership with increased knowledge.

Longitudinal and qualitative studies may be considered as future research to further investigate the results of this study. Longitudinal studies may allow for the exploration of the benefits of teachers gaining an increased level of specialized content knowledge over time. It could be possible for the spread of knowledge to not appear or appear in differing degrees until the participants have had a chance to experiment in their own classrooms and apply changes to their own instruction.

Qualitative studies could apply the same conceptual framework, but spend time observing teachers during collaboration and/or engaging in interviews with teachers who have increased specialized content knowledge. These observations and/or interviews could allow for the researcher to identify specific aids or hindrances to teacher leaders being able to share their knowledge and influence others. Interviews with teachers could also help to identify specific administrator activities or ways in which they demonstrate expectations that allow teachers to focus their conversations during collaboration on improving instruction in mathematics. A qualitative study could allow for researchers to use the knowledge gained by being in the field to refine the survey instrument to better capture the conversations occurring during collaboration that are creating changes in instruction and allowing for a focus on student thinking in a future quantitative study. Along the same lines, the results of interviews and observations completed during a qualitative study would allow for survey instruments to better capture the specific ways in which administrators empower teacher leaders to share their knowledge during collaboration. Including more specific administrator activities and ways of demonstrating expectations in the survey would allow for the researcher to better capture the influence of distributed leadership on the frequency of conversations in collaboration.

The literature review indicates an important link between (1) increased teacher specialized content knowledge and conversations occurring during collaboration and (2) distributed leadership, teacher leadership and conversations occurring during collaboration. However, very few studies show connections among knowledge, distributed leadership and conversations occurring during collaboration. This study aimed to investigate the potential support of each factor in focusing the conversations occurring during collaboration to meet the demands of the current shifts in mathematics. Teachers need to be supported as leaders by their administrators when they invest both time and resources to increase their knowledge about student thinking and instruction in mathematics so they are empowered to share this knowledge with their colleagues. For this reason, further investigation about the potential influence of the presence of distributed leadership and an increase in specialized content knowledge may help us to better understand how teachers can focus their conversations during collaboration to better address the needs of their students.

Hopefully this study has created a framework to further investigate the influences of distributed leadership and increased specialized content knowledge of the frequency of conversations occurring during collaboration. These conversations may support important instructional changes needed to address the content and practice standards in the CCSS-M which can help in better preparing students for future careers and post-secondary education.

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Appendix A

Survey Items

Survey Items

Through formal or informal conversations with colleagues, how often during the 2015-2016 school year have you discussed or received useful suggestions regarding how to:

	Never (1)	1-2 times/yr (2)	3-5 times/yr (3)	6-9 times/yr (4)	10 or more times/yr (5)
Evaluate student thinking though mathematics assessment items. (1)	❍	❍	❍	❍	❍
Engage students in active reasoning and analysis of challenging mathematical content. (2)	❍	❍	❍	❍	❍
Assist students in constructing important mathematical understandings. (3)	❍	❍	❍	❍	❍
Use questioning strategies to build students' mathematical understanding. (4)	❍	❍	❍	❍	❍
Engage students in worthwhile mathematics tasks. (5)	❍	❍	❍	❍	❍
Incorporate iconic (visual) mathematical models. (6)	❍	❍	❍	❍	❍
Analyze students' mathematical work. (7)	❍	❍	❍	❍	❍
Engage students in small group or whole-class discussions to promote mathematics learning. (8)	❍	❍	❍	❍	❍

Through formal or informal conversations with colleagues, how often during the 2015-2016 school year have you discussed or received useful suggestions regarding how to:

	Never (1)	1-2 times/yr (2)	3-5 times/yr (3)	6-9 time/yr (4)	10 or more times/yr (5)
Discuss the learning results or outcomes of mathematical tasks. (1)	❍	❍	❍	❍	❍
Discuss how to engage students in small group or whole-class discussions to promote mathematics learning. (2)	❍	❍	❍	❍	❍
Discuss how to engage students in active reasoning and analysis of challenging mathematical content. (3)	❍	❍	❍	❍	❍
Plan implementation of common mathematical tasks or problems. (4)	❍	❍	❍	❍	❍
Plan common mathematical assessments. (5)	❍	❍	❍	❍	❍
Analyze students' assessment results. (6)	❍	❍	❍	❍	❍
Analyze students' mathematical work. (7)	❍	❍	❍	❍	❍
Discuss the results of mathematical assessments. (8)	❍	❍	❍	❍	❍
Plan questions to use during lesson implementation that would build students' mathematical understanding. (9)	❍	❍	❍	❍	❍

Please indicate the frequency with which **your administrator(s)** have performed the following actions during the 2015-2016 school year.

	Never (1)	1-2 times/yr (2)	3-5 times/yr (3)	6-9 times/yr (4)	10 or more times/yr (5)
Attended professional development sessions alongside staff (1)	❍	❍	❍	❍	❍
Visited your classroom (outside of a formal evaluation) for the purpose of providing instructional feedback (2)	❍	❍	❍	❍	❍
Arranged for mathematics professional development sessions that are relevant to your teaching assignment (3)	❍	❍	❍	❍	❍
Given me useful feedback and/or suggestions on my teaching (4)	❍	❍	❍	❍	❍
Our school schedule is set up to support grade-level or grade-band collaborations (5)	❍	❍	❍	❍	❍
Arranged for mathematics specific collaboration time for myself and colleagues (6)	❍	❍	❍	❍	❍
Led or facilitated professional development sessions in which I participated (7)	❍	❍	❍	❍	❍
Reviewed student assessment results with me (individually or in a group) (8)	❍	❍	❍	❍	❍
Attended or participated in grade level or content area meetings (9)	❍	❍	❍	❍	❍
Given me useful suggestions on how to engage students in whole-	❍	❍	❍	❍	❍

group discussions to promote learning (10)					
Reviewed student work with me (individually or in a group) (11)	❍	❍	❍	❍	❍

Please indicate the extent to which you agree or disagree with the following statements.

My administrator:

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
Is focused on meaningful implementation of the Common Core State Standards. (1)	❍	❍	❍	❍	❍
Is focused on preparation for the ISAT (new version). (2)	❍	❍	❍	❍	❍
Recognizes my professional capacity to adjust instruction to meet students' needs. (3)	❍	❍	❍	❍	❍
Recognizes my professional capacity to adjust instruction based on state standards (4)	❍	❍	❍	❍	❍
Facilitates increasing teachers professional capacity to adjust instruction to meet students' needs. (5)	❍	❍	❍	❍	❍
Facilitates increasing teachers' professional capacity to adjust instruction to meet state standards. (6)	❍	❍	❍	❍	❍

Demographic Questions:

What grade level do you currently teach?

- ❍ Kindergarten
- ❍ 1st grade
- ❍ 2nd grade
- ❍ 3rd grade
- ❍ 4th grade
- ❍ 5th grade
- ❍ 6th grade

How many years have you been a classroom teacher? (including this school year)

- ❍ 1-3 years
- ❍ 4-10 years
- ❍ 11-20 years
- ❍ Over 20 years

Open Ended Questions:

1. Please list the mathematics professional development you have received over the past 2 years.
2. Any additional comments?