

UNDERSTANDING TEACHER LEADERSHIP AND PROFESSIONAL LEARNING
IN A SECONDARY MATHEMATICS DEPARTMENT

by

Christine Higgins

A Dissertation Submitted to the Faculty of
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in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy

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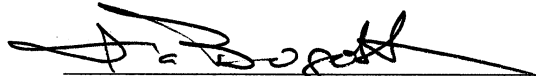
Christine Higgins

This dissertation was prepared under the direction of the candidate's dissertation advisor, Dr. Roberta K. Weber, Department of Curriculum, Culture, and Educational Inquiry, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the College of Education and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

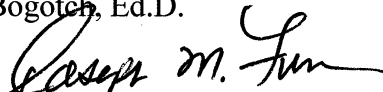
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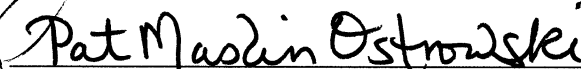
Roberta K. Weber, Ed.D.
Dissertation Advisor



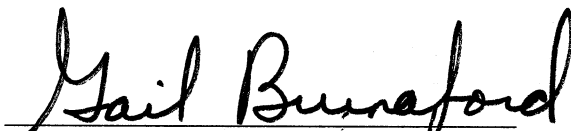
Ira Bogotch, Ed.D.



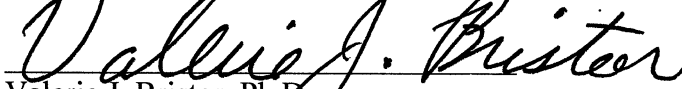
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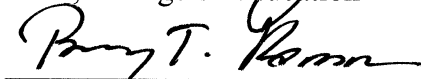
Patricia Maslin Ostrowski, Ed.D.



Gail Burnaford, Ph.D., Interim Chair
Department of Curriculum, Culture, and Educational Inquiry



Valerie J. Bristor, Ph.D.
Dean, College of Education



Barry T. Rosson, Ph.D.
Dean, Graduate College

July 11, 2013
Date

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I dedicate this work to Judy, with love.

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ABSTRACT

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This ethnographic study investigated teacher leadership and professional learning in a secondary mathematics department. Qualitative data were collected through in-depth face-to-face interviews, observations, and document analysis. It is the social aspect of the school environment and specifically, the subject department, which presents an opportunity for teachers to learn and share their expertise with one another in an informal setting and for teacher leaders to emerge using their expertise and close proximity to affect the learning of colleagues.

Teachers were asked to share their thoughts on leadership and learning within their department. A narrative was written to give the reader a better understanding of the day-to-day practices, behaviors, and habits of the teachers in the department, creating a holistic picture of the culture studied.

Data analysis was done using several levels of coding and theme recognition. The results show that teacher leadership is experienced informally through teachers sharing and talking about their practice. Teacher leadership is also experienced outside the department when teachers have opportunities to lead school professional development seminars and to practice leadership through role modeling. Professional learning is experienced one-on-one, as well as formally and informally through colleagues and organized workshops. Implications for administrators, department and team leaders, and policy implementation are discussed. This study may contribute to the development of teacher leadership and professional learning, which ultimately may lead to improving student achievement.

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Chapter 1: Introduction

Introduction

Leadership and learning have the potential to impact the professional role of teachers, as well as improve teacher practices, which ultimately may result in the improvement of student achievement. “Student learning depends on every teacher learning all the time” (Fullan, 2007, p. 35). It is the social aspect of the school environment that presents an opportunity for teachers to learn and share their expertise with one another in an informal setting. Teachers learn best by “studying, doing, and reflecting; by collaborating with other teachers” (Darling-Hammond, 1998, p. 7). Using the frameworks of adult and social learning theories, the qualitative study explored how teachers, in a specific subject department, share knowledge and improve their practice. In addition to understanding how professional learning occurs informally, the researcher was interested in how teacher leadership plays a role within the department and in the practice of teaching and learning. The principal has been the primary individual responsible for managing and leading schools, but the role of teacher leaders and the vision for teacher leadership is increasing and gaining recognition (Gigante & Firestone, 2008; Lieberman & Miller, 2004; York-Barr & Duke, 2004). A distributed leadership theory provides a framework that explains how individuals take on leadership roles as situation and expertise demand (Spillane, 2005). Therefore, the social setting of a

subject-department provides an ideal backdrop for a community of learners and leaders to emerge.

Culture plays a significant role in most organizations, often influencing how people think, feel, and act. Culture is crucial for promoting learning (Robbins & Alvy, 2004). The researcher used an ethnographic design to investigate the culture of a mathematics department and how learning and leadership are practiced. The researcher did not investigate formal professional development opportunities that may be presented during the time of this study; however, teachers may reference formal professional development and professional learning gained from these experiences. Also, the research did not address professional learning communities (PLCs) that are formed by the leadership of the school. However, the terms “professional learning,” “learning community,” and “communities of practice” are used throughout this study in reference to teachers’ learning and the communities they form through their professional relationships.

Statement of the Problem

Teacher leadership and professional learning are influenced by several issues. The first issue is the reform efforts that school leaders, teachers, government officials, and national organizations face as the educational needs of students rapidly change in our global society. Second, is the need for effective professional development that improves teacher practices. Teachers have notoriously been subjected to professional workshops, seminars, and course work that fall short of providing learning opportunities that sustain any type of sufficient knowledge to take into the classrooms. Furthermore, many schools ignore the influence of teachers helping teachers as the key to effective professional

learning (Reeves, 2009). The final issue is the changing leadership roles within schools and how this impacts the role of teacher leaders and their influence on informal learning within their respective subject departments.

The organization of high schools into subject departments has become an institutional norm for most secondary schools in the United States (Sisken & Little, 1995). In fact, the large size, the extensive offering of extra-curricular activities, and the use of academic tracking also help to define the American high school as a complex and challenging social institution (Darling-Hammond, L., Hightower, A., Husbands, J., Lafors, J., Young, V., & Christopher, C., 2005). Unlike the primary grades, the high school's organization is unique with its subject departments, size, and teacher's area of expertise. This organizational style can lend itself to providing teachers an environment conducive to building collegiality, providing professional support, and to developing informal leaders, as well as the formal leaders in the role of department chair or lead teacher.

The following discussion presents a brief history of mathematics reform, the National Council of Teachers of Mathematics organization, national and international test scores, and the most recent Race to the Top and Common Core reform initiatives.

Mathematics Reform Influences

Historically, school reform followed times of national crises. Schoenfeld (2004) described how "mathematical deficiencies" of men in the army in the 1940s and the launching of the Russian spacecraft, *Sputnik*, in 1957 led to curricular changes (p.256). Organizations, such as the National Science Foundation (NSF) and the National Council of Teachers of Mathematics (NCTM), were scrambling to improve science and

mathematics education. The 1960s focused on intellectual development and the structure of the academic disciplines, only to be undermined in the 1970s with a shift away from structure and a discipline-centered curriculum to concern for current social problems—“the Vietnam War, youth alienation, poverty, and racism” required a shift in attention (Franklin & Johnson, 2008, p. 466). In mathematics, the “new math” of the sixties was replaced with “back to basics” in the seventies (Schoenfeld, 2004, p. 257). This particular decade saw a return to the curriculum requirements that existed before the Sputnik era. In mathematics, students took algebra in 9th grade, geometry in 10th, a second year of algebra or trigonometry in 11th grade, and pre-calculus for some in the 12th grade. The problem that Schoenfeld (2004) discussed is the lack of problem solving skills that the curriculum offered; most of the mathematics was taught and learned through drill and practice. While scholars and educators debated the rigor of the mathematics curriculum, they were in agreement that reform efforts were needed as students continued to show poor performance on international competitions.

National Council of Teachers of Mathematics. As part of the reform efforts, the National Council of Teachers of Mathematics (NCTM) developed a series of standards documents in the hopes of improving mathematics education. In 1980, NCTM published, *An Agenda for Action*, which focused on problem solving versus rote memorization, which was a popular concept of back-to-basics in the seventies. The document also called for several other recommendations for mathematics programs including, incorporating the use of calculators and computers, evaluating students using other forms of assessment, an increase in mathematics study and more options available for students, as well as higher levels of professionalism for teachers (National Council of

Teachers of Mathematics, 1980). Schoenfeld (2004) continued to debate the emphasis on problem solving and wrote that many of the methods were “superficial,” simple word problems that were presented only eluded students from “the deeper findings about the nature of thinking and problem solving” (p. 258). Thus, the need for understanding the standards as they were used in practice by teachers was crucial in determining future directions for mathematics education.

Other documents published by NCTM included *Curriculum and Evaluation Standards for Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), and *Assessment Standards for School Mathematics* (1995). The 1991 document highlighted the connection between the teacher and the changing of mathematics education. Within this document, NCTM emphasized five major shifts in the classroom environment. First, teachers should promote “mathematical communities” where there is discussion and dialogue between students and teachers. Second, the teacher should no longer be the only source of knowledge; students need to use “logic and mathematical evidence” to verify concepts. Third, memorizing mathematical facts and formulas should be replaced by reasoning. Fourth, student’s need opportunities to conjecture and problem solve, and finally, mathematics should be applied to the student’s world and not represent just a “body of isolated concepts and procedures” (NCTM, 1991). These three documents present standards written by a national organization in an attempt to provide direction and goals for teachers and policymakers.

Twenty years after the publication of *An Agenda for Action*, reform efforts continued in mathematics as NCTM released *Principles and Standards for School Mathematics* (2000). The document had four aims: to provide a comprehensive and

coherent set of learning goals for students in pre-kindergarten through Grade 12; to act as a resource for teachers, administrators, and policy makers; to guide and inform curriculum development; and to provide a foundation of mathematics standards to stimulate discussion at the local, state, and national levels. State standards for mathematics have been closely aligned with the professional standards of NCTM. Martin and Berk (2001) reported that even “by 1996, 49 states had developed their own mathematics curriculum standards, in many cases closely following the recommendations of the *Curriculum and Evaluation Standards*” (p. 337). Furthermore, Martin and Berk (2001) contended that there is a “cyclical nature” between research and the series of standards released by NCTM (p. 328), therefore calling for continuous research in the field to provide evidence, evaluation, and recommendations to further the understanding of the connection between teachers and mathematics improvement.

National and international mathematics assessments. Reports on U.S. students’ mathematics performance are available from national and international studies. The following discussion gives a brief description and latest data from the Third International Mathematics and Science Study (TIMSS), the Program for International Student Assessment (PISA), and the U.S. National Assessment of Education Progress (NAEP). TIMSS is conducted by the International Association for the Evaluation of Educational Achievement (IEA), and provides math and science achievement data on students in the fourth and eighth grades from approximately 45 participating countries. TIMSS focuses on mathematics and science curricula and related classroom practices. It was first administered in 1995 and has been conducted every 4 years for students in fourth and eighth grades, with the latest data available from 2007. PISA is sponsored by

the Organization for Economic Cooperation and Development (OECD) and focuses on the literacy component in mathematics and science, meaning the ability to understand concepts and apply knowledge in different situations. Because of the focus on literacy, knowledge can be gained both in and out of the classroom for math and science. Beginning in 1997, PISA has been administered every 3 years to student who are 15 years old, with the latest data available for 2009.

The data from the last several years, displayed in Table 1 and Table 2, clearly show the United States consistently below the PISA international average in mathematics, and almost 100 points below the top-scoring country in TIMSS.

Table 1

Mean Performance of United States' 15-Year-Olds

	PISA 2003 <i>Mean Score</i>	PISA 2006 <i>Mean Score</i>	PISA 2009 <i>Mean Score</i>
U.S. Students Average in Mathematics	483	474	487
International Average	500	498	496

Note. Data from Organization for Economic Cooperation and Development (OECD, 2011).
<http://www.oecd.org/dataoecd/32/50/46623978.pdf>

Table 2

Comparison of Average Scores of Eighth-Grade U.S. Mathematics Students

	TIMSS 1995	TIMSS 1999	TIMSS 2003	TIMSS 2007
U.S. Students	492	502	504	508
Top Performing Country	609	604	605	598
TIMSS Scale Average	NA	505	466	500

Note. Data from National Center for Education Statistics <http://nces.ed.gov/timss>; NA = not available.

The data validate the concern for students' mathematical knowledge and raise justifiable questions regarding reform efforts and the future teaching and learning of mathematics. In contrast to the international data, national data are obtained from the NAEP test which is given every 2 years in Grades 4 and 8. The latest data available from 2011 report that 40% of fourth graders are "at or above proficient" in mathematics; 35% of eighth graders are "at or above proficient" in mathematics. While this is higher than the data reported in 2009, when 13% of fourth graders and 15% of eighth graders were proficient, there is concern that 60% to 65% of students are not proficient in mathematics (National Center for Education Statistics, 2011).

Race to the top and the common core state standards. The most recent reform effort took place in 2009 when President Obama signed the American Recovery and Reinvestment Act (ARRA), a sign of his commitment to improving math and science

education and international test scores. ARRA provided \$4.35 billion for the Race to the Top Fund, which gives grant money to states that are implementing comprehensive reforms to improve student achievement, closing achievement gaps, and preparing students for future success in college or the workplace. There are four core educational reform areas that Race to the Top addresses: adopting rigorous standards and assessments; recruiting, developing, retaining, and rewarding effective teachers and leaders; building data systems that measure student success and inform practices; and turning around the lowest performing schools. Florida received the grant money in September 2010 and was among 11 other states and the District of Columbia who received the competitive grant money (U.S. Department of Education, 2009).

The Common Core State Standards (CCSS) reflect the reform efforts of Race to the Top in establishing clear and consistent goals for student learning. As of December 2011, “the Common Core State Standards (CCSS) were adopted by 45 States, including Florida, and the District of Columbia” (U.S. Department of Education, 2009). These standards are in response to the discussion and research on national standards and students’ performance on international comparison tests. The National Governor’s Association and the Council of Chief State School Officers released the set of standards in June, 2010. A detailed report, published by Common Core, described the research reviewed of nine high-performing countries that consistently outscore the United States on international tests. The report revealed that top-performing countries had different perceptions on national standards, state standards, and standardized testing. Some countries embraced national standards; some embraced state standards; some embraced testing and standards. The differences continued in their demographics. The high-

performing nations are scattered across four continents, with no common borders, 14 official languages, and populations from 4 million to 125 million (Common Core, 2009, p. 6). However, the “common ingredient” was the “content-rich education” that these nations provided their students. “It is not a delivery mechanism or an accountability system that these high-performing nations share: It is a dedication to educating their children deeply in a wide-range of subjects” (Common Core, 2009, p. 5).

NCTM, the National Council of Supervisors of Mathematics (NCSM), the Association of State Supervisors of Mathematics (ASSM), and the Association of Mathematics Teacher Educators (AMTE) have joined together in support of the CCSS. A joint public statement was released on June 2, 2010 that states, “The release of the CCSS is a welcome milestone in the standards movement that began more than 20 years ago” (NCTM, 2010, p.1). These national associations support the “focused and coherent” mathematics curriculum that has been developed, and realistically, has many components that “echo the longstanding positions and principles” they have advocated for (NCTM, 2010, p. 1). The CCSS represent the latest effort to continue the “cyclical nature” between research and reform efforts (Martin & Berk, 2001, p. 328).

The purpose of discussing the mathematics reform efforts is the direction that it provides for the future of mathematics education and the impact that reform has on teacher decision-making, curriculum planning, and instruction. Teachers face daily challenges of implementing these standards and new reform mandates. Funding is crucial for school leaders in these challenging times. Therefore, adherence to state and federal mandates is a must; teachers need every opportunity to learn, to collaborate, and to share best practices.

Mathematics and technology. Teaching and learning is also taking on new meanings with the presence of mobile devices, such as cell phones, graphing calculators, iPads, and laptops in the mathematics classroom. These various tools provide students an alternative method of learning, and provide teachers an alternative method of delivery. Zelkowski (2011) reported that, “virtually every secondary school aged child has some sort of mobile device” (p. 40). Cooper (2012) contended that, “83 percent of teenagers 12-17 use the Internet or cell phones for personal communication” (p. 81), and they spend approximately 1 ½ hours sending text messages (Engel & Green, 2011, p. 39). Technology puts the learning directly in the hands of the students-opening up new possibilities for distance learning, virtual labs, student presentations, communication, and more.

Using technology in the classroom is a way for teachers to connect with students through a means students are most familiar with. The Internet and cell phones provide an outlet for students to express their ideas and understanding through mathematical writing. Teachers are using blogs, chats, and forums to develop higher-level thinking and reasoning by requiring students to problem solve, explain their knowledge through writing, and make connections with prior knowledge (Cooper, 2012). The Internet connects students and teachers around the world; it provides a “real audience and purpose for writing” (p. 81). “One teacher...notes that when his students see comments posted from people all over the world they recognize that their learning environment is not just limited to their classroom-it extends into the global sphere” (Cooper, 2012, p. 82). NCTM’s *The Principles and Standards for School Mathematics* (2000) recommends

written communication be used because, “it leads to reflection, clarification of ideas, and a greater depth of understanding” (Cooper, 2012, p. 80).

A pilot study on the use of cell phones in a pre-calculus class showed that technology was used in three ways in the classroom: (a) as a response system, (b) as a research tool, and (c) to collect evidence of student work through pictures and videos (Engel & Green, 2011, p. 40). As a response system, students used their cell phones to answer the question, “What is the purpose of the focus in a conic section?” This gave the teacher instant feedback on whether or not they had an understanding of the topic. The cell phone also acted a research tool in allowing students to access information when computers were not available. The students used their cell phones to research and discuss matrices. “The use of cell phones enabled the students to become active participants in their learning by using the Internet to search for background information” (Engel & Green, 2011, p. 42). Finally, the cell phone was used to record student work which gave students the opportunity to share and discuss their findings through visual means of pictures, slide shows, and videos. Accommodations, additional alternatives, and extended time were made for students without cell phones and for students with learning disabilities. The outcome of the pilot study showed gains in student learning in areas of participation, reflection, and various forms of assessments (Engel & Green, 2011, p. 44).

One of the most popular technology trends in schools today is the integration of iPads into the curriculum. The iPad offers a bigger screen than a cell phone but smaller than a laptop computer. The iPad is able to connect with the internet through Wi-Fi or, as a cell phone does, receive a data signal from a wireless provider. Most importantly for educational purposes, the iPad offers thousands of applications, commonly called “apps,”

that can actively engage students in the learning process (AL-Hazza, Christmann, & Lucking, 2012).

Technology in the mathematics classroom offers both opportunities and challenges in the area of teaching and learning. Managing the personal devices is a challenge for teachers; there must be clear expectations and policies in place. It also poses a dilemma for teachers that may be fearful of technology, critical of change, and dependent on a teacher driven curriculum. Aside from these challenges however, there exists a great potential for teachers' professional learning in the area of technology integration into the curriculum. It is imperative that we educate students for the world they live in; to do that, educators must be able to "use mobile devices to advance the educational setting of their classroom to a 21st century classroom" (Zelkowski, 2011, p. 40).

The Need for Effective Professional Learning

As teachers in Florida face the challenges of technology integration and new CCSS reforms, it is more important than ever that effective professional development is available. Allen (2006) described the problems faced by Ogden Elementary School, located in Ogden, Kansas, when after a decade of failing to meet any state standard, teacher leaders, administrators, and university professors formed a leadership team to address the problems. A specific problem noted by Ogden Elementary School was the lack of adequate professional development after the district had implemented a textbook reform measure. This initiative resulted in "a sustained, 18-month proposal for teacher learning, refining it based on teacher feedback" (Allen, 2006, p. 57). The lessons that were learned from the professional development project included: professional

development needs to be long-term; involve the teachers in planning their own professional development; multiple approaches are needed to develop both pedagogical and content knowledge; discussion and reflection between teachers clarifies and strengthens the learning; and, school level administrators must be supportive (Allen, 2006).

The need for creating professional knowledge is a must in the world we live in and expect our students to be prepared for. Skills such as autonomy, creativity, networking, and innovative, describe what employers and the ability to compete globally are demanding. As a result, educational leaders need to rethink leadership roles, teachers need to redefine their skills, and policy-makers need to allocate resources that best fit the needs of teachers and leaders. Hargreaves (1999) discussed several factors that favor the creation of knowledge in schools, which in turn, he claims leads to effective schools. These factors included: decentralization by giving teachers the responsibility of discussing ideas and decision making; recognition by school leaders of the specialized, expert knowledge held by teachers; an opportunity to “engage in high volumes of professional talk through intensive internal networking;” and, regular opportunities for “reflection, dialogue, inquiry, and networking” that is related to “professional knowledge and practice” (p. 126).

It is evident that teachers need opportunities to build their professional knowledge; there is a need for effective professional learning. Fullan (2007) stated, “Professional development as a term is a major obstacle to progress in teacher learning” (p. 35). Traditional professional development that uses workshop and lecture format to

bring “external ideas” in to change the practices of teachers in the classroom is “deeply flawed as a theory of action” (Fullan, 2007, p. 35). Additionally, Elmore (2004) stated:

The problem (is that) there is no opportunity for teachers to engage in continuous and sustained learning about their practice in the setting in which they actually work, observing and being observed by their colleagues in their own classrooms and classrooms of other teachers in other schools confronting similar problems.
(p. 127)

The type of professional learning that is needed involves “deprivatizing teaching,” changing the well-rooted norm of teachers working in isolation and privacy (Fullan, 2007, p. 36). It means that all teachers need to take risks, share ideas, open classroom doors; “the future of professional learning requires that we bite the bullet on this one” (Fullan, 2007, p. 36). Unfortunately, it is not an easy task; deprivatizing requires changing the culture, changing from professional development to “on-going learning” (Fullan, 2007, p. 36). Ball (2002) confirmed the problem of professional development, “We find ourselves in a period where developments in professional education have perhaps never been more important” (p. 4). Teachers are facing unprecedented challenges of student diversity, achievement, changing standards, accountability, and high-stakes testing that call for building professional skill; “ongoing professional learning” is needed to teach mathematics effectively (Ball, 2002, p. 5). Professional learning is engrained in the everyday activities and random meetings between colleagues. It is the discussion that takes place about student learning, subject-area questions, and the day-to-day challenges teachers face. Horn and Little (2010) posited that learning in the workplace is more likely to occur if the “talk” centers on “dilemmas and problems of

practice” (p. 183). Professional learning requires teachers to change the notion of teachers teaching and learning in isolation to a notion of social participation in a learning community. Lieberman and Miller (2004) also concluded that teachers’ social participation, “the capacity for joint work,” builds a learning community based on “collegiality, openness, trust, experimentation, risk taking, and feedback” (p. 10). The theoretical frameworks of adult and social learning help guide the notion of professional learning; understanding professional learning can affect teacher practices, which in turn can affect student achievement.

Guskey (2002) found that when teachers believed they were capable of affecting student achievement, they were more inclined to participate in professional development, more specifically the kind of professional learning that was related to their day-to-day practices and classroom instruction. Guskey (2002) defined professional development as “systemic efforts to bring about change in the classroom practices of teachers, their attitudes and beliefs, and in the learning outcomes of students” (p. 381). Therefore, understanding how teachers learn best and the most effective implementation of learning opportunities must be given careful deliberation and top priority if change is to happen. Too often, school leaders choose programs and activities that merely give the illusion of professional learning opportunities. This leads into the final concern. Leadership affects teacher learning.

The Changing Roles of Leadership

Researchers have acknowledged that the control, or hierarchical, approach to educational leadership that has existed in schools for many decades, is not beneficial to successful reform today (Andrews & Crowther, 2002; Frost & Durrant, 2003; Gronn,

2002; Harris, 2003, 2005; Spillane, 2004, 2005; Spillane, Halverson, & Diamond, 2001).

The concept of distributed leadership has emerged as a viable form of leadership that brings leaders and followers together; titles obscured in the process. This distribution of leadership occurs when the leadership function “is stretched over the work of a number of individuals where the leadership task is accomplished through the interaction of multiple leaders” (Spillane et al., 2001). It therefore considers, not only the formal roles of leadership that exist within an educational setting or subject department, but the informal roles of leadership that may have a “greater influence over leadership practice,” namely, teachers (Harris, 2005, p. 11).

Smylie, Mayrowetz, Murphy, and Louis (2007) described distributed leadership as “the sharing, the spreading, and the distributing of leadership work across individuals and roles throughout the school organization” (p. 470). The need for distributed leadership is evident in the many tasks, responsibilities, and roles that a school leader faces on a daily basis. Danielson (2007) stated with the expectations of principals being managers of people and tasks, instructional leaders of the curriculum, financial advisors for budgeting, and school building supervisors, “the demands...are practically impossible to meet” (p. 15). Furthermore, the principal’s ability to be an expert in each subject matter taught is not practical; it only makes sense to utilize the skills and expertise of teachers within each discipline. Danielson (2007) defined two roles that teachers can have: formal and informal teacher leaders. Formal teacher leaders often go through a selection process for a distinct authoritative position within the school or department; they have the power to purchase and select curricular materials for their discipline, as well as responsibilities for training, mentoring, and evaluating teachers. In contrast, the

informal teacher leaders “emerge spontaneously” often through recognition and encouragement from their colleagues; they do not have any formal “positional authority” (Danielson, 2007, p. 16). Regardless, teacher leaders are important assets to the school community. Their unique position within their discipline gives them the best opportunity to affect change in teaching and learning.

Lieberman and Miller (2004) further discussed various roles that teacher leaders take. Teacher leaders can challenge the accountability measures that are mandated; they have first-hand experience and knowledge of what works and what doesn't. Teacher leaders can impact curriculum and influence the rigor of coursework that will prepare students for the 21st century.

They can lead in re-shaping the school day, changing grouping and organizational practices, ensuring more equitable distribution of resources, actively implementing curricula that are sensitive to diverse populations, upholding high standards for all students, and guaranteeing all can share in the full bounty of good teaching, material, and support. In effect, teachers can lead a basic reconstruction of the very notions of ability, aspirations, and achievement.

(Lieberman & Miller, 2004, p. 12–13)

Teacher leaders can also work to change the professionalism of teaching. They can advocate for more meaningful professional development experiences; expand teacher learning through social learning and communities of practice. Teacher leaders can bring recognition to the accomplishments and expertise of colleagues, inspiring new as well as novice teachers in their discipline. Teacher leaders have the potential to create learning

communities that “sustain teacher commitment, passion, and persistence” (Lieberman & Miller, 2004, p. 13).

Frost and Durrant (2003) provided four arguments for teacher leadership that support the work of Lieberman and Miller (2004). First, school effectiveness is achieved by a “coherence” of individuals with a shared vision, not from a top-down, hierarchical organization (p. 175). Second, school improvement is dependent on teacher learning. It is more than implementing new curricular resources; it is about developing teacher’s professional practice through social relationships that focus on collaboration and sharing of knowledge. If teachers are not engaged with their “hearts and minds, there is merely implementation...rather than genuine development” (p. 175). Third, teachers need to know that they can make a difference in the professionalism of teaching by their actions and leadership abilities. Teacher morale and retention rates are positively affected when teachers feel they have a say in their future. Finally, the idea of schools as democratic organizations that promote and model behavior that is consistent with all members having the opportunity to lead, defines the notion of teacher leadership. Teacher leadership can apply to formal positions of leadership, as well as informal. Frost and Durrant (2003) referred to this as “development work,” where leadership is described as, “leadership for learning” (p. 176).

The rationale for teacher leadership is further supported in the research of York-Barr and Duke (2004). Part of their review of the literature surrounding teacher leadership asked the question, “Why focus on teacher leadership?” (p. 258). Their findings were categorized into four areas: the benefits of participation to the employee; the expertise about teaching and learning; the acknowledgement, opportunities, and

rewards for accomplished teachers; and, the benefits to students. Employees who are active in their organizations give their perspectives and share in the decision making process; they become part of the leadership team needed to run the organization, and because of their participation, they have greater buy-in and commitment to the success of the organization. Teacher expertise and “front-line knowledge” are at the foundation of improving teaching and learning (York-Barr & Duke, 2004, p. 258). Modeling of best practices and sharing information is needed for the success of the school. Teacher leadership opportunities give teachers the recognition they deserve; they become active learners themselves and are able to influence the work of other teachers, their students, and school administrators. The final benefit is to the student. Teacher leadership models a democratic society with shared decisions and teacher input; most importantly, teachers are learning themselves. Barth (2001) concurred, “Teacher leadership provides an inevitable and fecund occasion for teacher growth, only when teachers learn will their students learn” (p. 445).

The rationale for this study revolves around three important issues affecting teachers’ professional learning and teacher leadership. These are: the continued emphasis on reform measures, specifically mathematics reform that is related to student performance on national and international tests; the need to understand how teachers’ practices can be impacted by professional learning within a subject department; and how a distributed leadership style encourages teacher leaders to step forward and share their knowledge and expertise. The stakes are too high for school leaders not to recognize the potential that teacher leadership and professional learning can have on creating the conditions necessary for successful schools.

Purpose

The purpose of this ethnographic study was to understand what teacher leadership and professional learning look like in a secondary mathematics department. At this stage in the research, professional learning will be defined as the informal learning that is shared among the members of the secondary mathematics department; teacher leadership will be defined as leadership for the purpose of improving the teaching and learning of colleagues. Specifically, this study addressed the following research questions: What does teacher leadership look like in a selected secondary mathematics department? What are the formal and informal roles of leadership within this secondary mathematics department? How do teacher leaders in the department create opportunities for professional learning? How do teachers experience professional learning in a selected secondary mathematics department?

Significance

The potential contribution of this study is for teachers, teacher leaders, and other school administrators to better understand how professional learning occurs in a secondary departmental setting. With a better understanding of the culture of the mathematics department, school leaders are able to make informed decisions regarding professional development, leadership opportunities, and learning potential. Many factors can influence teacher learning, some internal to the organization, some external. It is necessary for school leaders to understand the importance of the internal opportunities that are within their reach to affect teacher learning. Hargreaves (1999) refers to this as “intellectual capital-the knowledge and abilities of the staff” which in turn creates “organizational capital” based on the collective knowledge of the group. Drago-Severson

(2007) suggests, “We need greater knowledge about practices that support teacher learning and growth by focusing on how teachers make sense of their experiences” (p. 71). Due to the departmental structure of high schools and teacher expertise in various disciplines, the subject department becomes a natural place for professional interaction and learning. It is therefore, a social community; an opportunity for people who share common interests, goals, and problems, to make sense of the world around them. Understanding adult learning and its social context within a department setting may help school leaders make better decisions regarding the professional development requirements for teachers, as well as help them understand the significance of teacher leaders and the contribution these leaders can make to the quality and effectiveness of the teaching and learning of their colleagues. It is through learning communities that effective schools operate (Giles & Hargreaves, 2006).

This study will ideally contribute to the literature base on teacher leadership and the role of teacher leaders as they focus on teaching and learning. Educational improvements and sustainability are possible through expanding the roles of teachers who are at the forefront of student learning, and who will ultimately affect student achievement. York-Barr and Duke (2004) report that “significant investments” have been made over the last few decades towards teacher development, teacher quality, professional reforms, and professional development schools. These initiatives ultimately call for “more active participation of teachers in the leadership and development of the educational enterprise” (p. 256). Therefore, it is significant to understand the role of teacher leadership in supporting teacher learning.

Theoretical Framework

Adult learning theory. Three theories guided this study: adult learning, social learning, and distributed leadership. The historical roots of adult learning can be traced as far back as the ancient philosophers of the Chinese, Greek, Hebrew, and Roman empires (Knowles, 1978). At that time, adult learning was assumed to follow the path of how children learned and therefore pedagogy, the art and science of teaching children, was used as the only framework to explain how both children and adults learned. In 1928, Edward L. Thorndike published *Adult Learning*, which gave a foundation to the idea that adults can learn and will do so differently from children based on interests and abilities. Another early theorist, Lindeman (1926) identified several important assumptions about adult learners that remain in present-day adult learning theory:

1. Adults are motivated to learn as they experience needs and interests that learning will satisfy; therefore these are the appropriate starting points for organizing adult learning activities.
2. Adults' orientation to learning is life-centered; therefore the appropriate units for organizing adult learning are life situations, not subjects.
3. Experience is the richest resource for adults' learning; therefore, the core methodology of adult education is the analysis of experience.
4. Adults have a deep need to be self-directing.
5. Individual differences among people increase with age. (cited in Knowles, 1978, p. 31)

From the early foundations of adult learning, many researchers have added their contributions to adult learning, some from the social sciences including Freud, Jung,

Erikson, Maslow, and Rogers (Knowles, 1978). Their contributions, however, consisted mainly of listed principles and concepts surrounding adult learning. A theory base was clearly absent from the literature until the term *andragogy* appeared as a “unified theory of adult learning” in the writings by Savicevic in 1967 (cited in Knowles, 1978, p. 48). The term had been used in the European literature on adult learning a decade earlier but was introduced in this country in 1968 by Knowles. Knowles defined andragogy as, “the art and science of helping adults learn” (Merriam, 2001, p. 5). The five assumptions of andragogy that differentiate it from pedagogy are that adult learners can direct their own learning; use their life-experiences as a “rich resource for learning;” have learning needs that are closely aligned with their roles in society; prefer problem-centered learning that can give them immediate knowledge to apply to situations; and, are motivated intrinsically versus extrinsically (Merriam, 2001, p. 5), paralleling several of the assumptions by Lindeman in 1926.

At about the same time, Mezirow completed a study on the learning experiences of women returning to school after an extended absence. From this study, Mezirow identified 10 phases of transformation beginning with a disorienting dilemma, self-examination of feelings, a critical look at assumptions, and then leading into other phases of exploration: planning, trying out new roles, and ending with self-confidence and “reintegration into one’s life” (cited in Taylor, 1998, p. 15). Mezirow used the term *transformative learning* that he defined as “the process of using a prior interpretation to construe a new or revised interpretation of the meaning of one’s experience in order to guide future action” (Mezirow as cited in Taylor, 1998, p. 12). Taylor (1998) explained Mezirow’s transformational learning is dependent on a person changing their “meaning

perspective” (p. 14). As people encounter new experiences, they will either accept or reject these experiences based on a number of factors related to a person’s personal knowledge, beliefs, and assumptions. Transformative learning occurs when a person accepts a new perspective resulting from an unfamiliar situation, known as a “disorienting dilemma” (Drago-Severson, 2007, p. 74). The growth or development that results will hopefully, lead to “more mature, more autonomous,” independent thinking (Merriam, 2004, p. 61). Mezirow (1997) stated that autonomous thinking is essential for the future of democracy and moral decision making; it is crucial that workers exhibit autonomous learning:

There is a growing consensus pertaining to the essential understandings, skills, and dispositions required for an adult learner to become an effective member of the workforce of the future. Economists recognize that resources should be directed toward creating a workforce that can adapt to changing conditions of employment, exercise critical judgment as it manages technology systems, and flexibly engage in more effective collaborative decision making. (p. 7)

Taylor (1998) identified three themes that are central to Mezirow’s transformational learning: experience, critical reflection, and rational discourse. Experience provides the platform for reflection and critical discourse to take place. Critical reflection is the most important aspect needed to transform a person’s way of thinking; this is done through self-reflection and discussion with others. “Transformative learning, according to Mezirow, reflects a process where meaning making becomes continually more clarified” (Taylor, 1998, p. 18). The process of questioning our beliefs and assumptions and reconsidering new ways of thinking occurs when individuals self-

reflect on experiences. In a subject department setting, teachers share many common experiences which provide the outlet for critical self-reflection and critical discourse with colleagues.

Drago-Severson (2008) wrote about adult development and four “pillar practices” that support transformational learning. She defined growth as “increases in our cognitive, emotional, interpersonal and intrapersonal capacities that enable us to manage better the complex demands of teaching, learning, leadership, and life” (p. 60–61). The four pillars are: teaming, providing leadership roles, collegial inquiry, and mentoring. The first pillar, teaming, consists of creating teams of colleagues to discuss, evaluate, and consider other opinions regarding curriculum, student work, instructional strategies, and philosophies on teaching and learning. Adults will “benefit from team members offering different kinds of supports and challenges for growth” (Drago-Severson, 2008, p. 62); the opportunity to learn from dialogue stimulates the growth of knowledge. The teaming has positive effects on communication, implementing changes, leadership opportunities, and decreasing teacher isolation. The second pillar, providing leadership roles, allows transformational learning to take place when principals share leadership roles and teachers have the opportunity to offer new ideas, take on challenging tasks, and to develop new perspectives that they may not have considered in their role as teacher (Drago-Severson, 2008). The third pillar, collegial inquiry, is defined as, “shared dialogue with the purpose of helping people become more aware of their assumptions, beliefs, and convictions about their work and those of colleagues” (p. 62). Creating opportunities for teachers to engage in dialogue about their practice can improve their learning, but also the overall organizational learning that may produce stronger student

achievement outcomes. The final pillar, mentoring, provides support on an individual level by pairing teachers together that have strengths and weaknesses. The opportunity allows for sharing expertise, reflecting on new practices, taking on leadership roles, and closely examining the teaching and learning philosophies that each brings to the experience.

Adult learning theory provides a theoretical framework for how adults learn. The researcher's investigation into how teachers learn professionally from one another through teacher "talk," collaboration, and leadership opportunities was examined using the four pillar practices described in the work of Drago-Severson (2008).

Social learning theory. This study refers to the work of Wenger's (1998) research on social learning and communities of practice. Wenger (1998) explained that his assumptions regarding the nature of knowledge are based on four premises: (a) we are social beings; (b) knowledge is a matter of competence; (c) knowing is a matter of participation-active engagement in the world; and (d) meaning is ultimately what learning should create (p. 4). The focus of this theory is on learning as social participation-participation, according to Wenger, refers to the "active participants in the practices of social communities and constructing identities in relation to these communities" (p. 4). Communities of practice are everywhere, some formal, some informal, but the underlying principle is that when we interact with each other and the world-we learn. Wenger (1998) described a community of practice as places where we "develop, negotiate, and share" ideas, theories and talk, a kind of community "created over time by the sustained pursuit of a shared enterprise" (p. 48). The secondary mathematics department provides a community of practice where teachers can develop shared meanings and improve their

practices. This researcher's design builds on the social learning theory and community of practice framework by observing how a culture of teachers within a mathematics department interacts, negotiates meanings, and ultimately learns from one another.

The term "learning organizations" has emerged in the literature within the last decade. In an attempt to use Wenger's model of "communities of practice," the learning organization literature tends to position itself between both the individual and the collective group:

Workplace learning is understood to involve not just human change but interconnections of humans and their actions with rules, tools, and texts, cultural, and material environments. Overall, then, workplace learning in this discussion refers not to formal planned training but to 'informal' learning. This learning is often embodied...in everyday practices, action, and conversation. (Fenwick, 2008, p. 19)

A common variable in the educational literature (Baxter, Connolly, & Stansfield, 2009; Fenwick, 2008; Miller, 2008) regarding the learning of organizations, communities, and individuals is the social nature in which teachers engage in each and every day of their workplace lives. Vygotsky's work on social influences on learning is important in the development and understanding of social practices, as well as his cultural-historical perspective that shaped qualitative research, and in particular, ethnographic design. Vygotsky's psychology maintained that "human thinking develops through the mediation of others" (cited in Moll, 2001, p. 113). It is through the interaction of people and their worlds which give meaning to objects, actions, and thoughts; "Vygotsky's special genius was in grasping the significance of the social in

things as well as people” (cited in Moll, 2001, p. 113). This study is intended to contribute to the understanding of how the socialization among teachers working in a “community of practice” affects teacher learning and teacher leadership.

It is difficult to define both “organization’ and “learning” since both take on varied structural, cultural, and social meanings. Baxter et al. (2009) remind us that learning in organizations takes on different meanings depending on the individuals and their roles within the organization. Baxter et al. (2009) presented a definition of learning in organizations as a “social process where individuals interact and learn from and among one another to develop existing and new skills, and to acquire new knowledge with the intention of leading to an improvement in working practice in their jobs” (p. 30). This ‘social process’ refers back to Wenger’s theory that learning is a social phenomenon because we are “social beings” (1998, p. 4). The organization depends on the learning of individuals and group members to sustain it. Furthermore, this collective learning must be shared and on-going. Fullan (2010) provided the argument that for organizations, whether schools, districts, or governments, to succeed, “collective capacity” is the key (p. xiii):

Better education, strange as it sounds, is not produced by individual teachers working with one student or one classroom at a time. It is coproduced by teachers and students across the years. Learning is a joint effort of lots of people working together on a given day and cumulatively over time. (p. 71)

The improvement of mathematics education is dependent on the teaching and learning of those in the organization. As research continually points to the need for mathematics educators to prepare students for real-world, global challenges, Wenger’s

work (1998) is increasingly being noticed for its emphasis on the importance of the social dimension using collaboration, sharing, and discussion to further this work (Krainer, 2003). This study used Wenger's social learning theory to investigate how mathematics teachers within the social setting of their department learn from one another.

Wenger's four components of social learning theory were used in an attempt to understand the culture of the mathematics department. These four components are practice, meaning, community, and, identity. Practice is what people do in order to perform their jobs satisfactorily. It is always a social practice. It is described as both "what is said and what is left unsaid, what is represented and what is assumed...the language, tools, documents, images, symbols, well-defined roles, ...as well as subtle cues, embodied understandings, underlying assumptions, and shared world-views" (Wenger, 1998, p. 47). However, practice is merely a function of human activity without meaning. "In the end, it is the meanings we produce that matter" (p. 51). Meanings are "negotiated" as individuals interact with one another and a constant "give and take" results (p. 52). Community is the mutual engagement of individuals that creates relationships among people. The diversity of the community creates relationships that may be both harmonious, as well as conflicting, "connotations of peaceful coexistence, mutual support, and interpersonal allegiance are not assumed" (Wenger, 1998, p. 77). Communities of practice are complex phenomena that are not easily reduced to a single category or standard. In real life, they are "mixtures of power and dependence, pleasure and pain, expertise and helplessness, success and failure, assessment and deprivation, alliance and competition, ease and struggle, authority and collegiality, resistance and compliance, anger and tenderness...friendship and hatred" (p. 77). The final component,

identity, is defined as the self-image that we develop through a “very complex interweaving of participative experience” in our specific communities (p. 151).

Engagement in practice gives us experiences that shape our identities. Identity can also be connected with our perspectives and the way we see the world, as well as the history, memories, events, and experiences in our community that shape who we are. Within this context, leadership has the potential to emerge as a possible identity for teachers who contribute individual areas of expertise, leading to the final theoretical framework guiding this study: distributed leadership theory.

Distributed leadership theory. This study is firmly grounded in the view that professional learning and teacher leadership can only flourish under the guidance of school leaders that develop a distributed leadership perspective. A distributed leadership theory posits that a collective leadership, using several members of the organization, is much more effective than any individual leader, which is in conflict with the dominant conception of the principal as “solo or stand-alone leader” (Gronn, 2002, p. 423). Furthermore, Spillane (2005) stated two problems with this heroic image. First, principals do not “single-handedly lead schools to greatness,” and second, these heroic accounts do not consider leadership practice (p. 143).

In his research on distributed leadership, Spillane (2005) addressed the question: What does it mean to take a distributed perspective on school leadership (p. 144)? Distributed leadership is not about what leaders do, it is about how they do it. It is about leadership practice. Leadership practice is defined as the interactions that take place between school leaders and their situation. Spillane (2005) stated, “My argument is not simply that situation is important to leadership practice, but that it actually constitutes

leadership practice-situation defines leadership practice in interaction with leaders and followers” (p. 145). Using a distributed perspective means that leaders will have both formal and informal positions of authority that vary depending on the situation. However, a primary characteristic of distributed leadership is the interdependence between these leaders (Spillane, 2005; Spillane et al., 2001).

The Distributed Leadership Study, a 4-year longitudinal study funded by The National Science Foundation, used the distributed framework to identify the interactions of school leaders in their daily lives (Spillane et al., 2001). The research was developed around four ideas: leadership tasks and functions, task enactment, social distribution of task enactment, and situational distribution of task enactment (p. 23). The distributed framework is based on concepts from distributed cognition and activity theory. The connection to social learning theory and Vygotsky’s work is the social environment which provides for human activity. The argument presented by the researchers is that school leadership is best understood as a distributed practice, “stretched over the school’s social and situational contexts” (cited in Spillane et al, 2001, p. 23). Spillane et al. (2001) further stated:

While individual leaders and their attributes do matter in constituting leadership practice, they are not all that matters. Other school leaders and followers also matter in that they help define leading practice. Further, the situation surrounding leaders’ practice-material artifacts, tools, language, and so forth-is also a constituting element of that practice and not simply an appendage. (p. 27)

The collective practice of several individuals, rather than the actions of one, has implications of affecting teaching and learning, as well as whole school reform (Darling-

Hammond, 1998; Fullan 2010; Hargreaves, 1999). Fullan (2010) reiterated this concept in his research on creating successful school systems. One of the key steps is the “cultivation of leadership at all levels to engage everyone in the moral purpose of improvement” (p. 54). Hargreaves (1999) wrote, the “knowledge-creating school” will favor “decentralization and flat hierarchies.” Groups will be given the decision-making power (p. 126).

Scholars have noted three reasons for the current interest in distributed leadership (Harris, 2005). First, it has a “descriptive power” that explains the practice of professional learning communities and communities of practice: “It is difficult to envisage how communities of practice operate unless leadership and other organizational components are distributed” (p. 10). Second, distributed leadership has “representational power” in that the organizational structures of schools are changing (Hargreaves, 1999). The 21st century model of schools, globally, calls for “collaboration and networking” across lateral boundaries to meet the complex organizational approaches to education. Lastly, distributed leadership is “normative power” which reflects the premise that leadership is “actively shared within the school”; the practice of single leadership is being replaced by teams, with “greater emphasis being placed upon teachers as leaders” (p. 10).

A distributed leadership framework guided the investigation of teachers collaborating, sharing information, and using leadership to influence professional learning within the subject department. The work of Lieberman and Miller (2004) posited three propositions that reflect major shifts in the “perspective and practice” of teaching (p.11). These propositions align with the frameworks guiding this study. The first is a shift from individualism to professional community-when teachers view their

work as more than classroom instruction, when they “build the capacity for joint work and develop norms of collegiality, openness, trust, experimentation, risk, and feedback” (p. 11). The second is a shift from the act of teaching to the act of learning collaboratively. Teachers gain “collective knowledge, confidence, and power to co-construct alternatives to standardized approaches;” and lastly, the third shift is from a “managed worker” to researcher, scholar, and leader.

Definition of Terms

Definitions of main terms that are important to this study are listed below.

Teacher leadership. The term *teacher leadership* has been difficult to narrow in the literature to one definition. York-Barr and Duke (2004) reported that the “lack of definition may be due, in part, to the expansive territory encompassed under the umbrella term ‘teacher leadership’” (p. 260). To validate this difficulty, York-Barr and Duke (2004) presented five definitions of teacher leadership in their review of literature, as well as five more “general conceptions of leadership” in which teacher leadership exists (p. 259). However, through their research and analysis, their own definition of teacher leadership emerged, “The process by which teachers, individually or collectively, influence their colleagues, principals, and other members of school communities to improve teaching and learning practices with the aim of increased student learning and achievement” (York-Barr & Duke, 2004, pp. 287–288).

The researcher is interested in the informal leadership roles that teachers assume, and therefore, will consider teacher leadership to be defined as leadership for the purpose of improving the teaching and learning of colleagues.

Subject department. For the purposes of this study, the “subject department” will be defined as the discipline departments found in secondary schools, such as the English department, math department, or science department. Typically the departments are comprised of a number of teachers, ranging from 4 to 40 and a department chair who holds a formal leadership position.

Professional learning. The term *professional learning* is difficult to define in the literature. Almost all research avenues led to “professional development” or “professional learning communities.” While both of these terms depend on professional learning, neither one will be used in depth to investigate the professional learning within the selected mathematics department. Therefore, several definitions are presented below that seem to encompass the meaning of professional learning that the researcher is interested in:

Learning is the process of enhancing learners’ capacity, individually and collectively, to produce results they truly want to produce. (Senge, 2006, p. 364)

(Learning) is centered on the critical activities of teaching and learning-planning lessons, evaluating student work, developing curriculum-rather than abstractions and generalities. It grows from investigations of practice through cases, questions, analysis, and criticism. It is built on substantial professional discourse that fosters analysis and communication about practices and values in ways that build collegueship and standards of practice. (Darling-Hammond, 1998, p. 8)

Distributed leadership. Distributed leadership is defined as a perspective on leadership that uses a system of practice comprised of a collection of interacting components: leaders, followers, and situation (Spillane, 2005).

Culture. Culture is defined as the sum of a social group's observable patterns of behavior, customs, and way of life (Fraenkel, Wallen, & Hyun, 2012, p. 509). The researcher is interested in investigating the culture of a secondary mathematics department to gain a better understanding of professional learning and teacher leadership.

Limitations and Delimitations

The limitations of this study exist in its methodology. The researcher chose an ethnographic approach to help understand how teachers within a selected a mathematics department use professional learning and teacher leadership to effect their practice. The participants were narrowed to a single secondary mathematics department in a parochial high school located in the State of Florida. The primary method of data collection was confined to in-depth interviewing and ongoing participant observations of the teachers within this department. Due to the nature of qualitative research and the use of an ethnographic design, the findings are subjective and open to various interpretations by the researcher. Ethnographic research is used to understand the culture of a certain group of individuals; to gain a holistic picture by observing their day-to-day activities, norms, and beliefs (Fraenkel et al., 2012). Therefore, the results are not generalizable, but may be used to promote understanding of teacher learning and informal leadership opportunities, as well as to promote future research.

Delimitations of this study are that the research does not look at professional learning communities or formal professional development activities; nor does this study take into consideration the school administration's viewpoint on teacher learning and leadership. In addition, other internal and external factors that contribute to the culture of the mathematics department that may also impact teacher learning and leadership were

excluded from this study. These include: other teachers in other departments, students, personal and family situations, community leaders, and district and state mandates.

Organization of the Study

This study is comprised of six chapters. Chapter 1 presents the statement of the problem, the purpose and significance of the study, the theoretical frameworks guiding the study, as well as the limitations and delimitations which develop the boundaries of the study.

Chapter 2 is a discussion of the literature surrounding this study. Selected research on educational leadership, teacher leadership, and distributed leadership is presented. Literature is also presented on the high school organization, mathematics department, and formal and informal roles within departments. Following this, the chapter ends with selected literature related to professional learning.

Chapter 3 follows with the research design and methodology. A summary of detailed procedures of data collection and analysis is included, as well as the sample, site, and instrument protocol information. A rationale is provided for the selection of methodology and design.

Chapter 4 is the narrative for this ethnographic study. Detailed accounts of some selected observations are presented in a story format to help the reader have a better understanding of the day-to-day activities of the teachers in the department.

Chapter 5 reports the findings of this study as they relate to the problem presented in Chapter 1.

Chapter 6 presents the conclusions and a discussion of the findings. This discussion includes an analysis of the theoretical frameworks introduced in Chapter 1, as

well as arguments related to the literature presented in Chapter 2. Questions regarding discrepancies and barriers of the research are discussed and suggestions for future research are addressed. The references are listed after Chapter 6.

Chapter 2: Literature Review

Literature Review

Within the last three decades, education in the United States has undergone significant reform initiatives. As a result of these initiatives, the practice of teacher leadership has emerged in the literature on educational leadership, professional learning, and school improvement. A brief search of the last five decades in the Educational Resources Information Center (ERIC) database shows this increase. The key descriptor of “teacher leadership” produced 67 articles from 1960 to 1990; whereas, the last two decades, 1990 to 2011, produced 1,101 responses under the same descriptor of “teacher leadership.”

Social Context of Teacher Leadership

Throughout history, teacher leadership seems to emerge in the literature that emphasizes a social context for school reform. School reform, on the other hand, seems to emerge in the literature during times of national crises and under the influence of interest groups. As early as the 1900s, interest groups began pressing their own agendas and views of knowledge. The Humanist movement focused on the “mental discipline” of subject matter and reasoning; the Developmentalists advocated for a curricular connection between the child and his environment; Social Efficiency educators believed that each person had a “pre-determined social role”; and the Social Meliorists advocated

for social justice issues in the curriculum (Schoenfeld, 2004, pp. 255–256). Enrollment in secondary education increased during the 20th century, and control over what was taught continued to be a highly debated matter. The life adjustment period of the 1940s and 1950s centered the curriculum on “life problems rather than subjects” (Franklin & Johnson, 2008, p. 461). The discipline-centered curriculum of the 1950s and 1960s focused on ways to improve intellectual development and produce the “scientists and engineers” needed to compete globally with other nations (Franklin & Johnson, 2008, p. 462). Our national security was at stake. Society has repeatedly influenced the curriculum and education. Teacher leadership began to emerge when society had concerns about student performance from the data released in the 1983 document, *A Nation at Risk*. High-quality education and high-quality teachers were now in demand. The federal government, as well as national organizations identified measures to promote teaching excellence and improve teacher knowledge. These changes gradually affected how teachers were perceived, their roles, and their professionalization (York-Barr & Duke, 2004).

Using a lens of social and adult learning theories helps to situate the culture of teacher learning that has often been perceived as learning in isolation, especially at the secondary level. Giles and Hargreaves (2006) advocate that schools should become learning organizations if they are to have any sustainability. Professional learning engages teachers to create a culture of collegiality where communities use the collective power of the organization to affect change. This in turn affects leadership.

Much of the recent research points to a school leadership approach that reflects a distributed style of leadership where the top-down approach of one individual is replaced

with various leaders at different levels (Gronn, 2002; Leithwood, 2004; Spillane 2005).

“The challenge of leading 21st century schools is so great that no longer is it effective for school leaders to single-handedly provide leadership for school improvement” (Horton, Green, & Duncan, 2009, p. 69).

The purpose of this study was to understand what leadership and professional learning look like in a secondary mathematics department. The research was guided by the following questions:

1. What does teacher leadership look like in a selected secondary mathematics department?
2. What are the formal and informal roles of leadership within this secondary mathematics department?
3. How do teacher leaders in the department create opportunities for professional learning?
4. How do teachers experience professional learning in this selected secondary mathematics department?

In answering these questions, a review of selected research on educational leadership, distributed leadership, and teacher leadership is presented. The use of a theoretical framework of distributed leadership theory provides the foundation for formal and informal roles of teacher leaders to emerge. The subject departments that define the high school organization provide the conditions for informal professional learning to occur. Social learning theory and adult learning theory are two theoretical frameworks that guided this study as teacher leadership and professional learning were investigated in a secondary mathematics department.

The research on principal leadership and formal teacher leadership roles is well informed (York-Barr & Duke, 2004). However, the research on informal learning within subject departments is not as prevalent, specifically with “mathematics teacher leadership only recently being discussed” (Yow, 2010, p. 43). The argument for this study is that teacher leadership has the potential to impact teacher’s learning and effectiveness through informal professional learning. This, in turn, may impact student achievement and sustain school improvement. When teachers open their classroom doors to each other to share knowledge, observe lessons, and discuss problems, they learn about mathematics and pedagogy; they become better teachers. Professional development workshops have been under fire for some time to provide more relevant learning for teachers. Leana (2011) wrote, “When a teacher needs information or advice about how to do her job more effectively, she goes to other teachers” (p. 30). Teacher leadership has become a viable form of school leadership within communities such as subject departments. This study may contribute to the literature on the professional learning opportunities that emerge in a secondary subject department through formal and informal teacher leaders. Understanding this phenomenon can have lasting effects on teachers, students, and the school organization as a whole.

The review of literature is divided into three main sections: (a) leadership; (b) high school organization and mathematics reform; and (c) professional learning. The leadership section addresses selected research on educational leadership, distributed leadership, and teacher leadership. The high school organization section is further divided into subject departments, secondary mathematics departments, teacher leadership roles within departments, and the influences of mathematics and technology reform. The

professional learning literature reviews selected studies and the latest research on the status of professional learning. The researcher did not investigate “professional learning communities,” but rather, the informal professional learning that occurs within a community of practice, such as a mathematics department.

Leadership

Leadership, for the purposes of this study, may be defined as “a process whereby an individual influences a group of individuals to achieve a common goal” (Northouse, 2004, p. 3). Northouse explained further that this definition is not a “linear,” one-way process, but rather a multifaceted and interconnected process in which both leaders and followers are affected by the relationship. Northouse’s definition emphasized that both leaders and followers are involved in the process of leadership, creating a mutual need for one another. This definition describes the attributes of a distributed leadership theory that posits that everyone has the opportunity to become a leader in some capacity, and that the power relationship is “blurred” between leaders and followers (Harris, 2003, pp. 316–317). Two types of leadership will be discussed: distributed leadership and teacher leadership.

Distributed leadership. Distributed leadership has become the focus of recent research, although the concept was first mentioned in the literature almost 70 years ago (Leithwood, 2004). Using the keywords “distributed leadership” and “education,” a brief search in the educational database produced 1,030 relevant peer-reviewed records, all of which were written after 1990. The term *distributed leadership* has been difficult to narrow to a single definition, its description often depending on whether it is being used as a quality to describe organizational leadership or as a practice of school leadership

(Spillane, 2005). The term, however, has often been associated with the terms *parallel leadership* (Andrews & Crowther, 2002), *shared leadership* (Lindahl, 2008), *democratic leadership* (Woods, 2004), and *communities of practice* (Printy, 2008).

Harris (2000) also addressed this style of leadership in the international literature from the United Kingdom when she wrote that for schools to be successful in these “turbulent” times, “staff at all levels” must be used (p. 82). Harris (2005) described three reasons for the interest in distributed leadership; these reasons are closely connected to this study. First, she noted that distributed leadership provides a “descriptive power” in that it provides a practice for professional learning communities in schools. Second, distributed leadership is a “representational power” of the school organization in that leadership practices are “lateral” as opposed to “vertical” in nature, crossing all boundaries. Lastly, the “normative power” of distributed leadership reflects the many individuals and teams of leaders that are replacing the singular model of school leadership (p. 10). Heng and Marsh (2009) echoed these same ideas. “Leadership no longer rests with an individual but extends within an organization, with leadership roles overlapping and changing with the different needs that arise” (p. 526).

Selected studies regarding distributed leadership. The following section examines the work of three selected researchers who have contributed to the research on distributed leadership. The first, Gronn (2002), researched distributed leadership as a unit of analysis in which he drew from the work of Hunt (1991) and Jaques (1995) on multilevel leadership and “stratified systems” (p. 424). He was also influenced by the work of C.A. Gibb, an Australian theorist on leadership, who wrote during the 1950s about distributed leadership. It was Gibb’s development of distributed leadership that

Gronn (2002) referenced when he discussed the “division of labor” within an organization and the various roles that individuals take on. Gronn (2002) presented a taxonomy of 21 different studies on distributed leadership as the unit of analysis in various fields of employment, organized by co-performance or collective performance and intuitive relations or institutionalized practices. Using Gibbs’ two forms of leadership, focused and distributed, Gronn addressed this continuum of leadership as a division of labor contingent upon relationships, sometimes based on numerical actions or concertive actions, but ultimately leading to a process of conjoint agency. He suggested that distributed leadership would be best served in the workplace if labels such as *leader* and *follower* were interchangeable and if there were no distinction of superiority. He further noted that role sharing and the training of individuals to take on management responsibilities at various times contribute to distributed leadership and that the unit of analysis of leadership should be understood as a collective view of interactive processes of both formal and informal practices (Gronn, 2002).

The second researcher whose work is central to current thinking about distributed leadership is Spillane, who in 2005 described two problems with the traditional “heroic” leader model. First, the concept is inaccurate, because school leaders (a term which often refers only to principals) do not “single-handedly” bring about school reform; and second, because in stories supporting this concept, leadership practices have not been taken into account. The Distributed Leadership Study, funded by the National Science Foundation, the Spencer Foundation, and Northwestern University’s School of Education, was conducted in hopes of gaining a better understanding of how and why

school leaders do what they do. This 4-year longitudinal study used school leadership practice as the unit of analysis (Spillane et al., 2001).

The Distributed Leadership Study used a distributed framework that investigated leadership practices as the school underwent changes in mathematics, science, and literacy instruction. Spillane et al. (2001) contended that the social context is an important component in the study of “human cognition,” and that an individual’s cognition is dependent upon both the individual and the environment. This contention is important because it demonstrates how this “interdependence” is “stretched over the school’s social and situational contexts” (p. 23). A distributed theory of leadership allows then for a distribution of leaders, both formal and informal.

Spillane (2005) explained that scholars tend to think of leadership practice as the “acts” of the individual leader. However, a distributed leadership theory is formed in the “interactions of leaders, followers, and their situation” (p. 149). Therefore, while some scholars tend to see distributed leadership as shared leadership, democratic leadership, or team leadership, Spillane contends that it is a distributed perspective, a way of thinking about leadership that allows for these types of leadership. Thus, he offered the following definition:

Shared leadership involves a formal leader plus other leaders, whereas distributed leadership is about the many and not just the few. It is about leadership practice, not simply roles and positions, and leadership practice is about interactions, not just the actions of heroes. (2005, p. 149)

Spillane's definition supports a transformational theory of leadership, discussed briefly by Leithwood (2004). A transformational theory of leadership hopes to bring about change through empowering others (Spillane et al., 2001). The subject department in a high school provides the social context that Spillane speaks of, as well as the opportunity for a distribution of formal and informal leaders.

An analysis of the research provides several conclusions. A critical component of the distributed perspective focuses on the interactions of leaders and followers and the situations that arise for such leadership practice. Spillane (2005) found that there is a need for multiple leaders depending on situation and subject area, and that situation defines leadership practices; Gronn (2002) argued the same concept when he referred to a need for multilevel leadership. Spillane's research documented "interdependency" as the primary characteristic of a leader's interaction. Similarly, Gronn (2002) described the division of labor as a process of conjoint agency. The importance of several leaders coming forward and providing a unified practice of leadership is what is at the heart of distributed leadership.

The third and final review of literature on distributed leadership examines the work of Smylie et al. (2007). Over a 3-year period, these researchers studied the relationship between trust and the development of distributed leadership in six secondary schools that received grant money for promoting the development of distributed leadership under the State Action Education Leadership Project (SAELP). Distributed leadership was defined as:

Leadership as sharing, the spreading, and the distributing of leadership work across individuals and roles throughout the school organization...the success of

distributed leadership depends not only on the individuals' performing leadership functions effectively but also on the new relationships among people doing this work. (Smylie et al., 2007, p. 470)

The researchers used a job characteristics model (JCM) to explain the relationship between the person and the job—and how this relationship affects organizational growth. A theoretical perspective on the role of trust explained that trust is a “dynamic phenomenon” that can strengthen or weaken an organization, but once the “foundation” of trust is laid, the organization can change for the better as a sense of commonality and collaboration are formed (Smylie et al., 2007, p. 473). Trust in an organization offers several benefits: Trust can bring about an “open exchange of information,” alleviating measures of control and monitoring (p. 474). Trust creates an atmosphere of “spontaneous sociability” among members of the organization (p. 474). Common goals are in place; cooperation and collaboration are present; and a social community develops. Lastly, trust promotes a mutual relationship with administration based on truthfulness, accuracy, and productivity (Smylie et al., 2007).

The research of Gronn (2002), Spillane (2005), Spillane et al. (2001), and Smylie et al. (2007) is important in helping to understand distributed leadership theory, one of the theoretical frameworks guiding this study. The premise of distributed leadership argues that successful leadership is not the work of one “heroic” leader, but the work of many leaders, whether formal or informal, that will influence and guide school improvement. While Gronn (2002), Spillane (2005), and Spillane et al. (2001) discuss leadership development, Smylie et al. (2007), in contrast, provide a rationale for the development of a distributed leadership style based on the need for trusting relationships.

Trust is one facet that is crucial to the sustainability of teacher leadership, as well as to the foundation for building collegial relationships to improve professional learning.

These three research studies were selected because of their in-depth work and connection to a distributed leadership theory. These studies help to explain what distributed leadership looks like and that it is not concerned with roles and individual acts of leadership, but with how leadership is distributed and to whom. The research shows how formal and informal leaders can emerge in an organization depending on the situation. Professional learning is connected to the trusting relationships formed, and understanding these dynamics and studying leadership practices can help to influence how teachers work together and learn together in their own environments.

Teacher leadership. The distributed leadership perspective lends itself to the emergence of teachers as a source of leadership that schools can utilize as they strive to improve teaching and learning. Schwab (1969) understood the important connection between teachers and designing the curriculum. He was said to have “changed the field forever” with his views on the practical, which emphasized four components that are necessary, as well as influential, to the curriculum: teachers, students, the environment, and the subject matter (cited in Craig & Ross, 2008, p. 285).

Teacher leadership defined. Due to the complexity and changing nature of school environments, researchers have struggled with a definitive definition of teacher leadership. Several definitions emerge from the literature: “Teachers who are leaders lead within and beyond the classroom, identify with and contribute to a community of teacher learners and leaders, and influence others toward improved educational practice” (Katzenmeyer & Moller, 2001, p. 5). “Teacher leadership is a form of agency that can be

widely shared or distributed within and across an organization, thus directly challenging more conventional forms of leadership practice” (Harris, 2003, p. 315). “Ultimately, teacher leadership, as we intend it, is about action that enhances teaching and learning in a school, that ties school and community together, and that advances quality of life for a community” (Crowther, 2009, p. xvii).

York-Barr and Duke (2004) confirmed the lack of clarity in their review of teacher leadership research when they stated, “the same is true of our findings...very few authors provide what would be considered a definition of teacher leadership” (p. 260). The researchers acknowledged that this lack of clarity might be due to the fact that teacher leadership has “evolved” from formal positions of department chairs and union representatives to informal roles using teachers as instructional specialists to the current, even more focused, recognition that teachers are the primary link to building a culture of collaboration and learning. The lack of a unified definition of teacher leadership supports the contention that this form of leadership is highly contextual and should be explored further.

Selected research on teacher leadership. Mangin and Stoelinga (2008) further discussed two important benefits for teachers who become leaders. First, such teachers have a direct connection to the classroom, possessing “special knowledge” and the ability to impact student achievement. Secondly, since teacher leaders do not have a formal power of authority, the issue of trust is used to develop and enhance professional learning, confirming the research by Smylie et al. (2007). As noted earlier, this is a concept that is important to this study, which explores linking teacher leadership to informal professional learning and the theoretical framework of social learning. Teacher

leadership has the potential to improve teacher quality; teacher quality has the potential to improve student achievement. The connection cannot be underestimated (Darling-Hammond & Bransford, 2005; Katzenmeyer & Moller, 2001).

As schools shift away from their traditional organizational structures, the research surrounding teacher leadership begins to develop in three areas: (a) developing a professional community that is accountable; (b) focusing on learning rather than teaching; and (c) building new roles of leadership that involve teachers as researchers, scholars, and mentors (Lieberman & Miller, 2004). Lieberman's (2004) view that teacher leaders emerge in three roles: as researcher, scholar, and mentor will inform this study. The teacher as researcher creates new knowledge through "reflective practice." The teacher as scholar makes the teacher's work public, giving credibility to the profession and providing the opportunity for discussion in a wider context beyond the classroom. Finally, the role of teacher as mentor allows teachers to impact the profession publicly with shared knowledge and best practices (Lieberman & Miller, 2004). The historical context of teacher leadership research begins with the work of Little (1985) and the landmark study of Miles, Saxl, and Lieberman (1988).

The research by Little (1985) and by Miles et al. (1988) was conducted in response to the curricular reform movement. The 1983 document *A Nation at Risk* highlighted adult illiteracy, poor test performance by U.S. students, and the inability of U.S. graduates to compete and perform adequately in the business world. Recommendations were made in the area of academic rigor, student expectations, teacher quality, and school accountability (Franklin & Johnson, 2008). Miles et al. (1988) stated that their research problem focused on the "effective schools" and "effective teaching"

improvements that were “expanding rapidly through education in the United States” (p. 158).

Little’s (1985) early work on collegial leadership sheds light on the importance of teachers learning from one another and the interaction that takes place as they take on the role of teachers as mentors. The Teacher Advisor Project took place in Marin County, California, over a 3-year period; the initiative used teachers, researchers, and teacher advisors or mentors to analyze videotapes of 8 teacher advisors observing and interacting with 14 teachers. The research concluded with two main points of interest. First, the interaction, described as a “conference,” between the teachers and advisors offered teachers a different form of professional learning that they had not experienced before; it was “stimulating and rewarding” (p. 34). Second, the project offered teachers a rare opportunity to look at and receive feedback on their own teaching practices and “classroom performance.” The advisors took a helpful approach, but were very specific in their goal of getting teachers to understand that “this is what I have done before, and this is what I could do for you” (Little, 1985, p. 35).

Miles et al. (1988), in contrast, used language such as “assisters” and “change agents” to describe the mentoring process of teacher leaders. The researchers reported that while their role “seems crucial,” it was not well defined, and empirical research was lacking (p. 158). The researchers used a sample of 44 change agents in three different programs. Interviews were conducted with teachers, principals, parents, and program managers, and 17 school visits were made with informal observations of classroom teaching, workshops, and meetings. The study identified six different approaches that were used to identify 18 specific teacher leader skills. In comparison with the earlier

research by Little (1985), who had six skills, or principles, for teacher advisors, the Miles et al. study identified several areas in which skills overlapped and could be classified together. Table 3 provides an overview of this comparison.

Table 3

Comparison of Teacher Leader Skills Between Two Research Studies

Little (1985)	Skills described	Miles et al. (1988)
Common Language	sharing ideas; proposing and teaching key ideas and terms to one another	Interpersonal Ease Group Functioning
Focus	using research, experience, observations to pinpoint topics to improve teaching	Training/doing workshops Educational General (master teacher) Educational Content (knowledge)
Hard Evidence	collecting data to improve teaching, learning, and discussions	Administrative/organizational Initiative-taking
Interaction	working together	Trust/rapport-building Collaboration Demonstration
Predictability	relying on a known set of topics; displaying explicit expectations	Managing/controlling Resource-building
Reciprocity	building trust through knowledge, skill, and hard work	Trust/rapport-building Support Confrontation Conflict Mediation

The research by Miles et al. (1988) revealed four implications for identifying skills of teacher leaders. First, some skills are actually characteristics that each leader naturally brings; second, the program, school, and district impact leader skills; third, some skills may have been overlooked due to the method of the study; and last, any

improvement measures made by the school may be difficult to connect to either the leader skills, or characteristics of the school, or characteristics of the district. Little (1985) concluded that, besides the six “advisor principles,” the role of leadership amongst teachers took two paths, one as a facilitator or one as a master teacher, also known as an advisor. The advisor role was more of an authoritative role that involved assertion and problem solving; whereas, the role of facilitator was more of an informal, assisting role. The skills of teacher leaders often place them in formal and informal positions of leadership within their school. Understanding the skills teachers need to emerge as leaders in formal and informal roles may inform this study.

A final look at research on teacher leadership focuses on the emergence of international literature from Turkey and the United Kingdom. Table 4 gives an analysis of three selected international studies within the last 4 years.

Table 4

International Teacher Leadership Literature Reflected in Three Studies

	Sunley & Locke (2010) United Kingdom	Muijs & Harris (2007) United Kingdom	Can, N. (2009) Turkey
Research Questions/ Purpose	To summarize the literature surrounding shared values and ideologies between teachers, head teachers, and the school organization	What factors support teacher leadership in schools which have hierarchical leadership structures?	Determine the leadership behaviors of teachers in primary schools
Methods	Extensive literature review on secondary schools in the UK Over 1000 references were used to develop a theoretical understanding of values	Three illustrative case studies: School A; School B; School C Interviews with Senior Management Team (SMT), Middle Management (MM), and classroom teachers	Data collected from literature reviews, questionnaires, and interviews
Literature Review	Personal and professional “values;” Studies of secondary school professionals; Reviewed theoretical studies surrounding “value” and the power of the teacher to make a difference	Leadership theories, distributed and collective leadership; Shared norms and collaboration; Influence of time on leader performance; Professional development	Historical look at teacher leadership; Principals influence on teacher leaders; Teacher actions and behaviors impact effectiveness of schools
Results	Little empirical research done in this area; Communication is needed between head teachers, teachers, and school organization; Personal values influence behavior	Evidence of strong, emergent, and restricted teacher leadership; Cultural and structural influences impact teacher leadership; Barriers exist to teacher leadership: uncontrollable variables, lack of time, lack of teacher experience	Leadership was at an “intermediate” level; Teachers perceive themselves as managers; Insufficiencies in instructional methods, professional development, support from families and the characteristics of the school

The studies reflect three common ideas. First, culture reflects personal values and behavior, which in turn, play a significant part in the characteristics of the school and leadership development. Values play an important role in the way people “think, act, and judge themselves” (Sunley and Locke, 2010, p. 417), but values displayed by teacher

leaders need to be “in harmony” with the values of the organization, otherwise, the position is marginalized (Mangin & Stoelinga, 2008). Therefore, leaders must understand the influence of socio-cultural conditions and the importance of values clarification that is rooted in Vygotsky’s social theory. Second, teacher leadership is an emerging idea in the United Kingdom and Turkey and the concept has not been fully embraced by all stakeholders. Teachers saw themselves as managers of the classroom, rather than leaders. There existed a divide between the school administration and the teachers; a lack of professional recognition and the opportunity for development of teacher leadership was noted (Can, 2009). Finally, there are barriers such as communication, time, administrative and family supports, and lack of professional development that hinder the opportunities of teacher leadership.

Barriers to teacher leadership. There is further consensus among scholars regarding the barriers to teacher leadership. Teacher leadership faces obstacles from principals, district leaders, and other building-level administrators; the added time and responsibilities required of teacher leaders may bring on stress and resentment; and the institutionalized norms may prohibit effective teacher leadership (Mangin & Stoelinga, 2008). Lindahl (2008) contended that schools have struggled with the concept of teacher leadership, or shared leadership, quite simply, because too often the roles of “leader” and “administrator” are confused and teachers find themselves doing administrative duties with no time left for their classroom duties. This promotes a model for failure. Furthermore, teachers are conditioned to working in isolation and fear the reactions of their peers when they are placed in a leadership role. Principals and other district leaders are under tremendous pressures of accountability. The pressures cause leaders to restrict

teacher leader's involvement and question their ability. Teacher respect and professionalism can become jeopardized (Katzenmeyer & Moller, 2001).

York-Barr and Duke (2004) also discussed the limitations in the research of teacher leadership in that most of the studies are “largely qualitative, small-scale case study designs that employ convenience samples and self-report methodologies...only a few are large-scale quantitative studies” (p. 257). Thus, clear evidence is lacking in providing connections between teacher leadership and student achievement, as well as, there is an “absence” of an agreed upon conceptual framework for guiding the development of teacher leadership (p. 256).

Teacher leadership is a complex, multi-faceted phenomenon that is highly contextual due to school cultures, formal and informal roles, collegial relationships, and other organizational characteristics. York-Barr and Duke (2004) stated that their review of literature on teacher leadership provided “little empirical evidence to support its effects” (p. 292); however, there exists a large number of teachers and administrators that have “ventured forth courageously” hoping to genuinely “improve teaching and learning” (p. 292). Teacher leadership will be examined within a selected high school subject department with the goal of understanding how teacher leaders affect teaching and learning.

High School Organization

Subject departments. Siskin and Little (1995) used the subject department as their unit of analysis in a 5-year project commissioned by the Center for Research on the Context of Secondary School Teaching (CRC). This was the first “comprehensive study” to link subject and departmental organization in high schools (Siskin & Little, 1995).

The research detailed several components of high school subject departments that relate specifically to this study.

First, the researchers discussed the subject divisions and sub-groups formed by the boundaries of the department (Siskin & Little, 1995). Here, “boundaries” were discussed not only as the physical layout of buildings or floors designated for subject areas, such as math, English, and science, but also the use of time, space, and the subject itself. The CRC study noted that high school teachers were most likely to “share” professional knowledge and feel “comfortable” within the confines of their subject department (p. 24). The organizational concept of subject departments is further discussed in the international research of Heng and Marsh (2009) from Singapore. By nature of the organization, subject departments have a sense of influence and power within the school that can affect change. Heng and Marsh (2009) discuss the importance of using these “powerful subcultures” to provide for professional learning and leadership opportunities (p. 530). Departments can have a positive influence in team-building and social relationships just by their “close proximity” to one another (Heng & Marsh, 2009, p. 530).

Second, teachers are members of professional communities where personal and professional relationships are formed based on subject expertise, experience, and interests. For Siskin and Little (1995), these communities were defined by those colleagues who shared a common interest in what was taught and learned; who understood the day-to-day tasks of teachers; and who provided curriculum, instructional, and personal support in the work. At the time of the study, the United States was continuing its focus on school reform with the standards movement. The data from the

study were taken from a small sample of eight math and science departments in the CRC study. These departments were undergoing reform changes on the local, state, and federal levels that dealt with standards and instruction.

The research also identified barriers of subject departments. Departments can also negatively affect the organization. The large size of the high school leads to subject department isolation, creating obstacles to a school-wide community and, a lack of communication, school vision, and goals across all subject disciplines (Siskin & Little, 1995).

Siskin and Little (1995) noted that the subject department had not been used extensively as a unit of analysis in research studies, therefore, leaving “widely divergent conclusions” as to its significance (p. 70). However, the CRC study found the strength of subject departments lies in the level of collegiality and community among members. Teacher surveys were used to distinguish the level of collegiality within the sector, district, school, and department as a quantitative variable that presented a continuum of variation. The results from their comparative analyses of academic departments found significant variation in the strength of departments. Strong departments showed collective agreement towards teaching and learning and strong professional networking; others were weak administrative units, showing a large amount of variance in teacher’s perceptions of collegiality, professionalism, and community (Siskin & Little, 1995, p. 74). Hence, the results confirm the complex nature of subject departments as subcultures that can positively or negatively impact school reform.

In the international research from the United Kingdom, Harris (2000) confirms the influence that subject departments can have. Known as the ‘realm of knowledge’

because of its subject boundaries, the department chair and the head of department (HOD) have a direct influence on teaching and learning (p. 81). Internationally, this is known as ‘leading from the middle’ or ‘middle managers’ (Harris, 2000; Frost & Durrant, 2003; Heng & Marsh, 2009). Research from Singapore describes middle leaders as those individuals who have responsibilities with management and pedagogical tasks and take on roles as the head of department or academic subject head (Heng & Marsh, 2009).

Teacher leadership roles in secondary subject area departments. The research on subject departments and teacher leaders addresses the study’s question into the formal and informal roles that emerge within departments. The study used a distributed leadership theory to explain the emergence of several leaders within the department. Within the subject department, the dispersion of power is seen in both formal and informal teacher leadership roles. In distinguishing between formal and informal roles, the teachers “work” inside or outside the classroom can make a difference. While formal roles are sometimes related to elected positions, explicit duties or responsibilities, informal roles, involve mentoring, planning, and influencing the classroom practices and professional knowledge of colleagues (Reeves, 2009). The influence of informal leaders can be especially powerful due to their affiliation with their department and other teachers. Donaldson (2006) writes, “As ‘one of us,’ their opinions, proposals, and practices can carry unusual power with colleagues. This is particularly true if a teacher’s leadership is informal, the product of his or her naturally earned authority and credibility among peers” (p. 120).

Formal and informal teacher leaders influence others through sharing, problem-solving, learning, and supporting one another in their professional relationships that are formed. Fullan (2002) wrote that “creating and sharing knowledge is central to effective leadership,” and knowledge is only created through a social process (p. 18). Fullan (2002) stated that leadership and sustainability are two interwoven concepts, where one cannot survive without the other. Sustainability, according to Fullan (2002) is developed in a social environment where learning is vital and leadership at all levels is essential.

Scribner and Bradley-Levine (2010) used an interpretive study of teacher leadership to examine the interactions and social experiences of teachers in formal and informal leadership positions. Their research discusses the varying sources of power that come from a distributed leadership perspective and how school culture and the ways teachers make sense of their work influence the meaning of leadership. The case-study approach involved observations, interviews, and document reviews that culminated in the researchers finding three categories, or themes, prevalent in the data: “organizationally legitimized roles, institutionally legitimized content area expertise, and gendered leadership roles” (p. 505). Across the continuum of teacher leadership, these categories give meaning to teachers who bring leadership experience; teachers who have the subject-area expertise; and finally, the dynamic of male and female leadership roles that are institutionalized by society’s expectations and norms. In the team teaching research, the male acted as the disciplinarian and the female as the assistant or helper. The research by Scribner and Bradley-Levine (2010) supports the need for continued investigation of formal and informal sources of teacher leadership power and the various

challenges teacher leaders face, whether from a lack of formal training or from the organizational norms that can sometimes inhibit leader's performance.

Formal roles. Returning to the definition of leadership by Northouse (2004), leadership is “a process whereby an individual influences a group of individuals to achieve a common goal” (p. 3). Leaders influence others through some power base, either positional or personal. Positional power comes from a formal role of authority, whereas personal power, results from the person's actions (Katzenmeyer & Moeller, 2001). Formal teacher leadership roles within the subject department, the department chair, head of department (HOD), master teacher, or lead teacher, are based on positional power due to their rightful authority to manage others. The combination of subject expertise and the proximity to teachers are two very important characteristics of the department chair role that make it an ideal position for teacher leadership.

Researchers agree (Feeney, 2009; Weller, 2001; Zepeda & Kruskamp, 2007) that the position of department chair has the potential for influencing school reform and student performance; however, it has been documented that the role of department chair is also “misunderstood” and somewhat “absent from the literature” (Zepeda & Kruskamp, 2007, p. 45). Furthermore, the roles and responsibilities remain unclear and vary widely in practice (DeRoche, Kujawa, & Hunsaker, 1988). Research by DeRoche et al. (1988) found several results that support the “misunderstood” role of department chairs. The selection process was varied and inconsistent; compensation for the role was more intrinsic than extrinsic; and, the responsibilities mainly included managerial duties of “budget work,” ordering textbooks, class scheduling, and curriculum planning (p. 136). Furthermore, the work of Weller (2001) and of Zepeda and Kruskamp (2007) confirmed

that the majority of department heads receive little or no formal training for their position; the demands of additional duties put constraints on professional development and instructional supervision opportunities; the role caused much conflict and ambiguity between what department chairs actually did, their written job description, and the support provided by their principals.

Mangin and Stoelinga (2008), more recently, discussed the renewed interest in formal teacher leadership roles in the area of instructional leaders. Due to legislative mandates of school accountability, high stakes testing, and other school reform models, instructional teacher leadership is one initiative to increase student achievement. Content and procedural knowledge were factors contributing to the level of influence of instructional teacher leaders (Mangin & Stoelinga, 2008). Similarly, Handler (2010) said that teachers who take on formal roles as curriculum leaders must “demonstrate a sophisticated understanding of education as a political and social enterprise” (p. 35).

Therefore, the role of instructional leader can be quite complex. Instructional leaders must walk a fine line between an administrator who is responsible for teacher evaluations and a colleague who is responsible for providing support, expertise in content knowledge, and assistance in teacher development. Zepeda and Kruskamp (2007) discussed many of the obstacles instructional leaders face: insufficient guidance and support for the role of instructional leader; not enough time for handling the managerial, as well as the duties of instructional supervisor; and, role ambiguity given no official job description. This supports the notion that the formal role of department chair, as instructional leader, while in a position to affect teaching and learning, is not being used to its fullest potential. The research on formal roles within a department will guide this

study in evaluating the teacher leader roles within the perspective subject department to be studied.

Informal roles. Informal teacher leadership is defined as a teacher who is not “formally designated” to a leadership position of authority (York-Barr & Duke, 2004). In their meta-analysis of teacher leadership research, York-Barr and Duke (2004) concluded that informal teacher leaders are sometimes recognized more as a leader than those in formal, authoritative positions. This was confirmed as well by the research of Supovitz (2008) when he studied the roles of instructionally influential people within a school organization. Over 200 interviews were taken with teachers and school leaders, with specific questions to teachers about whom in the school they turn to for help in the various areas of course planning, classroom management, and student performance.

The data revealed that other teachers were more influential than department chairs, school administrators, counselors, and others in all three areas of curriculum, discipline, and low-performing assistance networks. The majority of influential people in this study were teachers who held no formal leadership positions. Therefore, informal leadership is not based on positional power, but personal power. These two kinds of power are discussed further by Northouse (2004) and are important to understand as informal leaders emerge in situations.

Positional power comes from a person who is in a formal, authoritative role and may exhibit characteristics of power over; personal power comes from power that is given to an individual from his or her followers based on a personal strength that is important to the followers (Northouse, 2004). The research by Supovitz (2008) shows a distributed leadership theory in practice where the leadership is not based on formal

authority, but seems to suggest leadership relies on multiple sources depending on the situation. Distributed leadership has been described as being “lateral,” as opposed to “vertical,” crossing various organizational boundaries (Harris, 2005, p.10). Katzenmeyer and Moller (2001) discuss positional and personal power in school leaders; “Teacher leaders are approachable and influence primarily through their personal power” (p. 7).

Expert teachers are an example of teacher leaders that use their subject expertise to influence others, a source of personal power. Teacher expertise has been addressed frequently in the literature as an attribute of teacher leaders (Berliner, 2001; Katzenmeyer & Moeller, 2001; Murphy, 2005; Sisken & Little, 1995). For example, Hunzicker’s (2010) research looked at three teachers’ learning experiences as they went through the National Board for Professional Teaching Standards (NBPTS) Program. Through reflection and analysis of teaching practices, student learning, and assessment critiques, all three teachers reported significant “learning” throughout the process (p. 7). Hunzicker (2010) identified the certification as one “pathway to teacher leadership” (p. 9), confirming that teacher leaders can emerge using their expertise in informal roles of “peer leadership” and “instructional leadership” (p. 10). In addition, Sisken and Little (1995) confirmed that subject expertise is a “powerful warrant for teacher leadership,” as well as a foundation for teacher communities and professional learning (p. 52). In this final review of literature regarding teacher leadership and subject departments, Sisken and Little (1995) found that regardless of the contextual differences between and within high school departments, subject departments “are dominant factors” in developing leadership at the high school level (p. 51). The connection to subject expertise was documented as an element necessary for legitimate leadership by teachers.

The research on teacher expertise informs this study about the connection between subject departments and informal teacher leaders. While Siskin and Little (1995) contended that department leadership may be strong or weak depending on the culture, institutional norms, and formal leadership of the school, the tradition of subject departments at the secondary level to influence teachers and community is strong. Therefore, a look at research specific to mathematics departments addressed the researcher's question of how teacher leaders can create opportunities for professional learning.

Secondary Mathematics Departments

The following section looks at three research studies conducted within secondary mathematics departments. Printy (2008) researched factors that influenced the learning of secondary mathematics and science teachers within their "communities of practice" (p. 188). The research closely follows the perspective of Wenger's (1998) social learning theory, a theoretical framework identified for this study. A "community of practice" is defined by Printy (2008) as a "naturally occurring" community that comes together through mutual interests, who also engages in activities that develop knowledge and share of information (p. 191). Printy (2008) specifically pointed to the "non-formal teacher learning" that is usually representative of the priorities in educational matters. Teachers are apt to learn in the community they identify with most; informal leaders emerge to keep the community focused and to maintain a social learning environment. Printy (2008) found that formal leadership by the department chair is an influential factor in determining the success of the communities of practice. These findings highlight the important role departmental leaders have in developing the professional learning within

their subject departments. Printy (2008) found that the role of the principal did not directly influence teacher's learning within their communities however, their role was important in developing and sustaining a school vision, and providing support and guidance to the departments and teachers.

Similar findings about leadership and collaboration within a mathematics department are found in the work of Flores and Roberts (2008). Three California high school mathematics departments were studied in order to gain a better understanding of how they maintained successful student achievement in algebra for all subgroups. The demographics of the three high schools were similar: large student bodies, majority of students were Latino, Asian, or African American, and a significant percentage of students received free or reduced lunches. One department chair admitted that the reason students don't pass algebra is a lack of "fundamentals" (p. 308). This idea parallels Bruner's (1960) concept of the structure of a discipline. The importance of structure was the process of "continual broadening and deepening of knowledge" in order for the student to more easily transfer knowledge at a later date (Bruner, 1960, p. 17).

The gains in mathematics achievement were attributed to three areas of influence: leadership, instruction and collaboration, and culture. The brief discussion that follows highlights some of the findings from the research. Department chairs consistently used data to guide their decisions; they were actively engaged and respected "by all, or most of the teachers" within the department (Flores & Roberts, 2008, p. 314). The department chair and team of teachers decided together what topics in algebra were most important to cover, as well as, what wasn't. Teachers taught both high and low level classes and professional development was organized around department needs. One administration

team believed that “most of the learning occurs from within” and therefore, made a concerted effort to hire qualified professionals that believed in the importance of learning as a community (Flores & Roberts, 2008, p. 110). Cultural influences included expectations the school community expressed for student learning, and the emphasis on learning opportunities available throughout the school day. Each high school had its own set of “rules, values, and practices” (p.314). Flores and Roberts (2008) write, “Ultimately, we found that developing strong teacher leadership within the school, supporting that leadership, and empowering teachers with the freedom to find solutions to complex learning problems was the answer” (p. 315).

Yow (2010), in contrast to studying communities, looked specifically at secondary mathematics teacher’s perceptions of teacher leadership. Two findings emerged from the study. First, teachers had difficulty defining “teacher leadership,” which reflects the ambiguity in the literature as well. Second, the perceptions and acts of teacher leadership fell within a continuum ranging from “behind the scenes” on the left and progressed to more “apparent and noisy” on the right. The way teachers viewed themselves as teacher leaders fell in the same pattern on the continuum as well. Those who worked in their departments as lead teachers, or curricular specialists were on the left of the continuum guiding fellow teachers, while teachers who worked outside the school building in district and county matters were moving to the right of the continuum (Yow, 2010). The continuum reflected teacher’s activities, experiences, voice, and power that shaped the leadership in each department. Yow (2010) noted that two teacher leaders who were on the far right of the continuum were both male, indicating that gender may play a role in teacher leader characteristics. Yow (2010) writes, “the women in this

study tended to be more relational and less autocratic whereas the men tended to be more instigative” (p. 53).

The three selected studies (Flores & Roberts, 2008; Printy, 2008; Yow, 2010) offer different glimpses into teacher leadership within a mathematics department. Printy (2008) offered research supporting the department chair as an influential factor in promoting and sustaining professional communities; Flores and Roberts (2008) provided evidence that addresses mathematics reform using “smaller and localized efforts” (p. 312), and Yow (2010) provided a rubric for secondary mathematics teacher leadership that gives “concrete examples” of leader activities (p. 54). The research supports the notion that teacher leadership is a complex phenomenon within secondary mathematics departments, and non-formal learning provides math teachers better opportunities to gain content and pedagogical knowledge. Understanding these complexities can help future teacher leaders in mathematics, as well as school administrators, as they strive to improve teaching and learning.

Kanold and Ebert (2010) provided an example of students’ mathematics achievement increasing after teacher leaders and teacher groups worked collaboratively on the mathematics curriculum and professional learning programs. Data from 24,000 students enrolled in algebra, geometry, pre-algebra, and advanced algebra from 56 middle schools and 48 high schools revealed that before reform efforts, only “9% of the students tested were able to pass high school algebra” (Kanold & Ebert, 2010, p. 12). This alarming statistic prompted district-wide initiatives that included establishing expert mathematics committees, professional development for department chairs, small teacher teams that focused on collaborative work, and implementation of rigorous and effective

assessment practices and meaningful lessons. “Both the district and the committee realized that a hallmark of teacher leadership is the ability to help teachers collaborate with one another and work independently to establish best practice teaching in mathematics” (Kanold & Ebert, 2010, p. 14). As a result of these efforts, the first semester common assessment data revealed that 15,000 more students would have passed the exam “based on 2008 levels of proficiency” (p. 16).

Selected studies and influences on mathematics reform. The research on the teaching and learning of mathematics is presented from two studies using information from the Third International Mathematics and Science Study (TIMSS). TIMSS was conducted by the International Association for the Evaluation of Educational Achievement (IEA), and provides math and science data on student achievement from approximately 45 countries. The study has been administered every 4 years from 1995 to 2007. Tabernik and Williams (2010) used data from the 1995 TIMSS to show that targeting teachers’ learning and knowledge is important in impacting student achievement on the Ohio Achievement Test for Mathematics (OATM). Results from the TIMSS (1995) showed that student achievement in the United States was “significantly lower than...students in peak-performing countries like Singapore, Korea, Japan, Hong Kong, Belgium, the Czech Republic, the Slovak Republic, Belgium, Switzerland, France, Hungary, the Russian Federation, and Ireland” (p. 34). The results prompted members of the Ohio Department of Education to consider how teachers’ content knowledge may affect student scores; their focus was on teachers’ professional development in the area of content knowledge and pedagogy (Tabernik & Williams, 2010).

The study was conducted between June 2004 and April 2007. The teachers were selected based upon their involvement in a professional development program called Science and Mathematics Achievement Required for Tomorrow (SMART). This program was designed to impact the teaching and learning of mathematics through sharing resources and strategies, developing “powerful practices,” and bringing together teachers and administrators to understand the supports needed for a standards-based mathematics curriculum (Tabernik & Williams, 2010, p. 35). When over 4,100 OATM student test results were reviewed, of teachers participating in the SMART professional development program, there was a positive relationship between the scores and the participation of teachers in the targeted program. In addition, student “passage rates” increased more when teachers possessed mathematical backgrounds and participated in over 90 hours of professional development (Tabernik & Williams, 2010, p. 42). Other findings of the study showed that teacher certification and years of experience also contributed to higher student achievement results. From the qualitative data that were gathered from 11 teachers, their principals, and district personnel, teachers and administrators differed on their perceptions of professional development:

The teachers talked about the need for professional development as a means of sharing experiences with colleagues and learning new skills.... Administrators, however, tended to have a more global view of professional development, looking at it through the lens of fostering long-term change. (Tabernik & Williams, 2010, p. 44)

The interview data revealed teacher's frustration with "district professional development activities," (p. 44) which supports the previous research discussed on professional development that tends to be administered from a top-down approach (Darling-Hammond et al., 2005).

The research of Tabernik and Williams (2010) provided evidence that "sustained and targeted" professional development lead to increased student performance on one state's mathematics achievement test (p. 48). TIMSS (1995) provided evidence that top-performing countries provide long-term, content driven, professional development as a means of school reform. The results indicated a need for teachers' professional learning to be given substantial consideration as a means of reform in the area of mathematics.

The second study by Hiebert, Stigler, Jacobs, Givvin, Garnier, Smith, and Gallimore (2005) referred to the TIMSS (1999) Video Study. The Video Study used 638 eighth-grade mathematics lessons from seven countries in order to provide a comparative analysis of mathematics teaching. Along with video-taped classroom lessons, the study reviewed supplementary teacher resources, sample textbook pages, and teacher questionnaires with the goal of improving ineffective systems. The data provided from TIMSS (1999) showed the United States behind the six other countries in the study in regards to student's mathematics achievement (Hiebert et al., 2005).

Using the data from the video study, the researchers found four teaching characteristics that were different between the United States and the high-performing countries. First, the level of mathematics challenge was low for the United States. This meant that routine exercises were used; students followed familiar procedures to solve problems; and there was a lack of mathematical reasoning. Second, the United States

emphasized using a procedural process versus conceptual development when making mathematical connections. This meant that for some problems, only the answer was provided, and there was no discussion or reasoning by the students beyond that. The third characteristic was the amount of time spent on review material in the United States, and the fourth characteristic was the lack of lesson coherence. Lesson coherence was defined as “the implicit and explicit interrelation of all mathematical components of the lesson” (Hiebert et al., 2005, p. 124). The reason for highlighting the research by Hiebert et al. (2005) is the impact that alternative systems of teaching can have on school reform measures to improve mathematics learning. If teachers are made aware of the differences in teaching practices between low-performing and high-performing countries, it will hopefully open up the discussion for their own professional learning. Observing mathematics lessons, whether through videotape or observation, allows teachers a unique learning experience that Tabernik and Williams (2010) referred to as “make it-take it” professional development that teachers could use the “next day in the classroom” (p. 44).

Both studies are contrastingly different in how they used TIMSS data in their research. Tabernik and Williams (2010) used the student achievement data to focus on the need for sustained and targeted professional development to effect teaching and learning. Whereas, Hiebert et al. (2005) used the video analysis data to show effective and ineffective classroom teaching practices, in an effort to effect teaching and learning. However, in comparison, both studies are hoping to effect mathematics reform by changing the “system of teaching,” and not just one feature of it. Looking at past international mathematics achievement results and the research on reform efforts will

guide the researcher's investigation of professional learning and teaching practices that are used in a secondary mathematics department.

The advisory panel's report. *Foundations for Success: The Final Report of the National Mathematics Advisory Panel* (NMAP) was released in March, 2008. This report was in reply to a "presidential executive order" to examine mathematics education in the United States (Spillane, 2008, p. 638). This document signified the on-going governmental influence in education policy and practice. Spillane (2008) argued that NMAP's national report, whose intent was to advise President George W. Bush and Secretary of Education Margaret Spellings on the nation's progress in mathematics education, must be considered in the "political and institutional contexts" that it is (p. 638). Spillane reminds the reader that the government has become involved in educational matters since the possible threat to the nation's supremacy in international dealings with the launching of *Sputnik*, by the Russians in 1957. The federal government has used state and local governments to carry out many of its programs, including the Elementary and Secondary Education Act of 1965 and the No Child Left behind Act of 2001 (NCLB) (Spillane, 2008).

The importance of mentioning NMAP is its recommendations for instructional policy and practice. These recommendations, for the improvement of mathematics education, have been previously advised by NCTM over the past few decades. They include a mathematics curriculum that is focused more on "critical topics," more efficient assessments, improved teacher quality, and more "valid and reliable research findings" that will impact educational decisions (Spillane, 2008, p. 641). Spillane addressed the challenges that these implementations bring, including that the educational system is

comprised of a “vast array of policy makers, practitioners, and extra-system providers” that must first acknowledge there is a problem with mathematics education (p. 642).

Spillane’s (2008) analysis reminds the reader that the document, NMAP, is not policy and is advisory only. Furthermore, he reiterated the problems educators face when policy and politics that begin at the “statehouse” are transferred to the “schoolhouse” (p. 642). Unfortunately, it is these policies and practices that teacher and administrators, who are held accountable for, rely on for future directions in mathematics education. Becoming familiar with the discourse and challenges government policies bring may help educators see the influences and impending directions in mathematics reform-it signals that people are concerned and discussing the future of mathematics education.

The research presented supports the work of teacher leaders and the need to have a better understanding of this potential source of influence in affecting student achievement and mathematics reform efforts. The call for sustained and targeted professional development highlights the problems teachers face in learning their practice. To affect teaching and learning, a culture of professional learning is necessary.

Technology and Secondary Mathematics

The use of technology in the mathematics classroom is a current practice and an area where both teachers’ professional learning and leadership may impact student achievement. Three selected research studies address the contributions and challenges of using technology in secondary mathematics classrooms. Goos and Bennison (2008) conducted a case study that used surveys to understand teachers’ use of computers, graphing calculators, and the Internet to teach secondary mathematics. Pierce, Stacey, Wander, and Ball (2011) focused their research on using mathematics analysis software

to reinforce multiple representations. More specifically, they used an “adapted lesson study” approach that incorporated the Texas Instruments’ Nspire (CAS) handheld calculator into the algebra lessons (p. 99). Ruthven, Deaney, and Hennessy (2009) used the “practitioner model” as a framework for their case study of two teachers teaching technology supported lessons.

The belief that technology has the potential to impact student learning was consistent in the research reviewed, “Technologies offer new opportunities for students to communicate and analyze their mathematical thinking by enabling fast, accurate computation, collection, and analysis of data, and exploration of the links between numerical, symbolic, and graphical representations” (Goos & Bennison, 2008, p. 102). Technology offers students the opportunity to discover, share, and investigate more open-ended questions. Teachers observe students “going beyond the lesson” in ways that are “only possible because of the availability of the graphing software” (Ruthven et al., 2009, p. 289). In addition, technology can support student learning by building confidence, independence, and providing a variety of activities to ease boredom (Ruthven et al., 2009). Pierce et al. (2011) explained that multiple representations are fundamental in mathematics in order to effectively develop mathematical understanding, “researchers have shown that linking multiple representations to each other promotes understanding rather than rote learning” (p. 97). NCTM Standards (1989) also addressed the need for mathematics to be taught using multiple representations,

Different representations of problems serve as different lenses through which students interpret the problems and solutions. If students are to become mathematically powerful, they must be flexible enough to approach situations in a

variety of ways and recognize the relationships among different points of view.
(p. 84)

However, teachers play a crucial role in the successful use of classroom technologies (Goos & Bennison, 2008). Socio-cultural theories informed the research by Goos and Bennison (2008), stating that learning is viewed as the “product of interactions with other people and with the material and representational tools offered by the learning environment” (p. 104).

In addition, Ruthven et al. (2009) stated the importance of teachers developing their “craft knowledge,” or “system of situated expertise” in the area of new technologies in the mathematics classroom, including modifications to the physical layout of the classroom, the time component of lessons, activity formats and inductive thinking, and classroom routines (p. 281). More specifically, the practitioner model highlighted several themes in the research that directly related to the use of graphing technology: easier to produce graphs, increasing efficiency; students overcame difficulties more easily, building assurance; mathematical conjecturing and verification processes were improved; important concepts were visible through altering parameters; “laborious written work” was avoided; and a collaborative student environment was created (Goos & Bennison, 2009, p. 295).

The study by Goos and Bennison (2008) used a survey methodology to investigate both the school technology resources and individual teacher practices that support technology through the use of computers, the Internet, and graphing calculators. The School Technology Survey revealed that computer software programs were limited in schools, “fewer than two-thirds of schools had access to graphing software;” class sets

of graphing calculators were more prevalent at 73%, versus individual ownership at 24.7% (Goos & Bennison, 2008, p. 113). Teachers' levels of experience also varied when it came to using the three types of technology, "only 12.3% said they had been using the Internet with mathematics classes for more than 5 years; 26.6% had been using graphing calculators, and 42.7% computers" (p. 114). The Teacher Technology Survey results concluded that while most teachers were convinced that technology use in mathematics allowed students ease and instant feedback, teachers were unsure whether or not the technology hindered basic skills, improved attitudes towards mathematics, or was able to help students learn mathematical concepts (p.116):

Although schools appeared to be providing access to software and graphics calculators, simply having these resources available does not mean that teachers and students are able to use them whenever appropriate or necessary... Teachers who responded to our survey cited lack of time and meaningful professional development as major obstacles.... It was not surprising, then, to find that the most pressing need for professional development identified by teachers centered on how to integrate technology into classroom teaching in ways that improved students' understanding of mathematical concepts. (Goos & Bennison, 2008, p. 126)

The research also noted the lack of teacher confidence in using technology, the limited access and availability of the technology, and the need for continued, appropriate professional development (Goos & Bennison, 2008). Technology integration into secondary mathematics classrooms is increasing considerably and becoming a significant part of the learning process for students. Teachers need the help of one another as they

develop their practice with the new technologies. This is an area where the intersection of teacher leadership and professional learning is crucial for math department members.

Professional Learning

Professional learning carries three important elements in the educational field. First, the learning must be about the practice. “To learn anything relevant to performance, professionals need experience with the tasks and ways of thinking that are fundamental to the practice” (Cohen & Ball, 1999, p. 11). Second, the practice must be grounded in teaching and learning, meaning that the use of investigation, experimentation, analysis, and reflection is crucial to the learning. Finally, continued learning in professional communities is necessary to sustain a culture of professionalism focused on the improvement of teaching and learning (Cohen & Ball, 1999).

Professional learning, whether in formal or informal capacities, gives teachers the opportunity to reevaluate and change their practices to impact learning. Therefore, this is a powerful avenue to school reform and sustainability.

The researcher investigated how teachers share their knowledge and use teacher leadership in a social environment of a selected mathematics department. The researcher did not go into depth about the formal professional development programs that most schools require teachers to participate in. Rather, the researcher was interested in the informal professional learning that occurs when teachers, in their formal and informal roles of leadership, help other teachers within a subject department. Professional learning is, therefore, situated within the theoretical frameworks of social and adult learning.

The research of Miller (2008) used a case study design with “ethnographic methods” of observations, interviews, and document collection to gain a better

understanding of the informal communication between pre-service teachers. While Miller's research focused on pre-service teachers, due to his role as one, the problems discussed are problems that most teachers face in their practice, "problems related to classroom management, developing a conception of subject matter and how to teach it, understanding the ways students learn, assessment practices, working with colleagues...as well as a host of other predicaments" (p. 78). The methodology that Miller (2008) used is important to the study because of the "holistic overview" that was gained from understanding the participant's conversations (p. 82). Using in-depth interviews, focus groups, documents, and video recordings, Miller (2008) categorized the data with initial codes and completed the analysis based on themes and patterns that emerged. The culture depicted from the analysis process was a "highly complex" environment (p. 91). The use of this research on problem-based conversations offers insight into informal professional learning that can occur between teachers.

The process of raising evidence-supported problems in a public space with peers provided an opportunity for the participants to approach, in a unique way, the complex teaching challenges that face them at this stage of their development.

The problem-based conversations...offered them access to a range of perspectives while fostering a climate of mutual vulnerability, risk-taking, and trust. (p. 91)

The researchers used an ethnographic design to understand the culture of teachers within the mathematics department. Therefore, Miller's (2008) research on the knowledge gained about teaching and learning that surface from problem-based

conversations may support the learning that occurs between teachers in the selected math department.

The following section looks at research on the national status of professional learning, a 3-phase study conducted by the National Staff Development Council and Stanford University, funded in part by the Bill and Melinda Gates Foundation (Wei, Darling-Hammond, & Adamson, 2010; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009).

Status of Professional Learning

Professional learning in the United States has the potential to improve teachers' practice and impact student learning. The first report from the National Staff Development Council revealed that U.S. teachers, in comparison with teachers abroad, participate in short-term professional development, and have limited access to long-term, content-driven professional learning opportunities. Data gathered from the Schools and Staffing Survey (SASS) and the National Staff Development Council's Standards (NSDC) Assessment Inventory revealed that "teachers work in isolation, take a heavy dose of workshops, and do not receive effective learning opportunities" (Wei et al., 2010, p. 1). The second report acknowledged that professional learning, which is needed to impact student achievement, has fluctuated back and forth. Eleven indicators were used to assess teachers' time spent in professional development on specific content areas, as well as the time new teachers spent with their mentors. The study found similar results to the first report, with small increases in the support and collaborative time for new teachers. In addition, there was a slight increase in teacher participation in four of the six topic areas of professional development that covered content area, computer instruction,

reading instruction, classroom management, teaching students with disabilities, and teaching English language learners. While the study also indicated an increase in professional development overall for teachers, there was a substantial decrease in the number of long-term sustained contact hours (Wei et al., 2010).

The third and final report studied four states that have been successful in improving student learning. A case study approach was used to look at the policies, strategies, and structures in place regarding professional development in the states of Missouri, New Jersey, Vermont, and Colorado. While the four states showed different approaches to professional development, there were some common findings. Among the findings, state education agencies set guidelines for professional development; continuous use of surveys provided feedback on the quality of the programs; beginning teachers had mentoring programs; professional learning communities and teams were used to target teachers' individual needs with content and teacher practices; networking was used with professional organizations and universities for program support; and, resources for providing professional development opportunities were productively used (Jacquith, Mindich, Wei, & Darling-Hammond, 2010, pp. v-vi).

The study confirmed that professional learning is a high priority for school leaders focusing on educational reform. However, based on the data reported from these particular studies, there is much to be done in the area of understanding how professional learning relates to student learning. Additional findings of the study identified that there is variation in the participation in professional development across grade levels, schools, and student populations. Also, on average, only 2.7 hours were allotted for opportunities for teacher collaboration and cooperative learning (Wei et al., 2010, p. 4). The

implications in the study indicate that for successful professional learning to occur, teachers must be given adequate opportunities to engage in cooperative efforts. Elmore (2007) wrote that three types of expert knowledge are needed to impact systemic school reform efforts; one type is social knowledge. Elmore (2007) contended that teachers create “self-sabotage” when they work in isolation and create “cultures of personalized practices;” if school improvement is to happen, schools must move towards “a culture of shared practices” (p. 32).

Creating opportunities for sharing practices has been one of the guiding standards behind the emergence of professional development programs within the last decade. Guskey (2002) defined professional development programs as “systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of students” (p. 381). Guskey (2003) further stated that the connection between reform legislation, the No Child Left Behind Act of 2001, and professional development is the attention to “highly qualified” teachers (p. 4). Guskey (2003) had three goals in mind when he analyzed 13 different lists of characteristics of effective professional development. First, he determined whether the lists were generated from similar sources of evidence of professional development. Second, he determined if there were any overlapping characteristics that appeared on more than one list; and finally, he compared the lists with the *Standards for Staff Development*, put out by the National Staff Development Council in 2001.

Guskey (2003) did identify several results that have direct implications to this study. First, the characteristic of effective professional development-identified most frequently was the enhancement of “teachers’ content and pedagogical knowledge” (p.

9). Second was the development of “collegiality and collaborative exchange” (p. 12). Finally, many of the lists identified using teacher leaders and principals as instructional leaders. These results indicate that researchers and practitioners feel strongly about developing teachers’ content and pedagogical knowledge through collegiality and teacher leadership.

Four years after the study by Guskey (2003), Fullan (2007) wrote an essay entitled, *Change the Term for Teacher Learning*. In fact, his opening sentence said that the term ‘professional development’ “has run its course” (p. 35). He continued, saying that professional development may actually be a hindrance to teacher learning and school improvement. Cohen and Ball (1999) further wrote that most staff development is “disconnected from deep issues of curriculum and learning” (p. 4). They continued by stating that “one-shot” workshops are full of tips and advice, handouts and “vinyl binders” (p. 4). Fullan (2007) explained that “external ideas alone” will not create sustained changes and only gives teachers and administrators a false impression of doing something worthwhile and important (p. 35). Instead, recent research is indicating that teachers need to participate in continual learning and become “deeply immersed” in professional communities (Fullan, 2007, p. 37).

Darling-Hammond and Bransford (2005) stated that teaching and teacher quality can significantly impact children’s learning, as well as their “life chances” (p. 13). The focus on teacher quality, as a process of school reform, has been given substantial time, money, and effort in the way of professional staff development. However, most of these efforts have produced little to no significant effects (Hill, 2009; Sykes, 1996) Furthermore, Sykes (1996) acknowledged that there are many organizations with high-

stakes interest in professional development such as, school districts, consultants, professional associations, state agencies, and this has caused the structure of professional development to become “deeply institutionalized” (p. 465). Fullan (2007) seemed to understand the need resulting from this ‘institutionalism’ and the necessity for “day-to-day cultural change” through continued learning. He wrote:

Learning is not workshops and courses and strategic retreats. It is not school improvement plans or individual leadership development. Rather, learning is developing the organization, day after day, within the culture...it is about openness of practice, precision, creativity...learning from each other inside and outside the organization. (p. 28)

Selected research studies on professional learning. An example of an effort to develop a system of professional learning is seen in the work of Darling Hammond and Bransford (2005) and the San Diego school reform research. The study occurred over a 5-year time period from 1998 to 2003 and evaluated the reform efforts at three levels: the state, the district, and the school. The researchers conducted over 250 interviews and over 200 observations of classrooms, meetings, and conferences, as well as collected pertinent data on demographics, leadership, and survey information. Interestingly, the study used two opposing perspectives on how to improve teaching. First is the perspective of “top-down” or outside influences that impact learning. Examples of this approach are usually associated with control factors, accountability fears, and incentive programs to produce results. The second approach is from a “bottom-up” perspective that is situated in the social environment of teacher learning. This approach takes into consideration the challenges and circumstances rooted in teachers’ learning and practice.

It is this perspective from the work of Darling-Hammond and Bransford (2005) that the study is most interested in, particularly the work at the high school level. The following explanation of the results confirms that reform at the high school level is difficult, but beginning the conversations of change in teacher practices is one step forward in the right direction.

Darling-Hammond and Bransford (2005) explained that a system of learning was constructed at all levels of the schools, including “instructional leaders, principals, teachers, and staff developers—all of whom were responsible for their own learning and that of their peers” (p. 84). The difference in results between the elementary schools and the high schools was significant across many indicators. In the elementary schools, student achievement increased; the difference between lower level and higher level student performance was less noticeable; principals focused more as instructional leaders; communities of learners were developed to support professional learning; and, professional development became more focused on teacher learning, including professional conversations, peer observations, and videotapes of practice.

At the high school level, however, the reform efforts were not as successful. Students “remained the lowest-performing group,” graduation rates decreased, and many students required remediation when they reached the college level (Darling-Hammond et al., 2005, p. 155). Problems also arose in the working relationships between teachers and subject coaches; questions of expertise often created conflict between experienced and non-experienced teachers. The difference in complexities of school structures between the elementary and high school levels contributed to the success, or lack of, the reform efforts. Many of the efforts at the high school level were created by district leaders in a

“top-down” fashion, and it was not until changes were made, that were specific to high school, that some improvement was noticed. Teacher collaboration increased and the most effective professional development strategy reported was the use of teachers to consistently “model and support” teachers’ learning (p. 91). This discussion reinforces that high schools are complex organizations where reform efforts are not easily put in place, but to foster the best outcome requires open communication, innovation, commitment, and a desire to improve professional practice. Bottom-up reform efforts eventually made an impact in the percentage of high schools in the San Diego study meeting their target scores. This gives hope that the very difficult process of implementing school reforms is not all about changing structures, but, as Fullan (2007) mentioned previously, about changing cultures within schools to reflect professional learning at all levels.

The work of Little (1982) addressed school improvement, staff development, and instructional leadership within the context of the school as the workplace. The methodology employed a “focused ethnography” to analyze three elementary schools and three high schools considered urban and desegregated. Little’s methodology provides an additional example of ethnographic research-the methodology of this study.

Little’s 1-year study (1982), involved a 19-week period where 105 teacher interviews, 14 administrative interviews, and 80 classroom observations were conducted. Interviews were semi-structured and guided by an “inquiry matrix and discussion guide” (p. 328). Teachers’ talk was carefully recorded, transcribed, and used to generate a set of descriptive statements. The analysis included 3,190 statements that reflected teacher practices or some type of role relationship in the organization. Role theory was used as a

theoretical framework, along with three other principles, recurrence, immanent reference, and contrast, to help construct a view of the practices teachers engaged in. The practices were further characterized by the frequency, the “degree to which persons approved or disapproved their inclusion in the work,” and their value (p. 328). Little (1982) used three descriptors, “high success, high involvement,” “high success, low involvement,” and “low success, high involvement,” to categorize school success and teachers’ involvement in learning practices (p. 326).

The results indicated that successful schools have several characteristics. First, teachers engage in collegial work, “frequent, continuous, and increasingly concrete and precise talk about teaching practice” (p. 331). Second, teachers are frequently observed and provided with useful feedback. This practice is similar to the “lesson study” that Ball (2002) writes about as a way for teachers to engage in different learning opportunities to improve professional practices. Taken from the research of Japanese teachers, lesson study describes a kind of “professional work” where teachers collaborate to design, teach, test, and analyze their work (Ball, 2002). Ball (2002) specifically relates this to the teaching of mathematics, “Most likely what is significant is not mainly that teachers work with one another. It is more likely that what matters is the unusual ways in which it engages teachers in learning mathematics in ways connected to practice” (p.11).

The third characteristic of successful schools found by Little’s (1982) research was teacher involvement in the curriculum planning, research, evaluation, and preparation of the material. These characteristics are considered a requirement for “long-term (school) improvement” (p. 331), and parallel the ideas of the Japanese lesson study. The final characteristic was the practice of teachers teaching teachers. The role of

instructor changed dependent on the teacher's expertise and situation. This idea supports Spillane's (2005) work surrounding distributed leadership where he explained that leadership is dependent on the situation and subject expertise. Little (1982) found that these four school practices clearly separated successful schools from less successful schools:

In successful and adaptable schools, all four classes of "critical practice" occur widely throughout the building and throughout the work week: training sessions, faculty meetings, grade or department meetings, hallways, classrooms, offices, workrooms, and teachers' lounge. Collegial experimentation is a way of life; it pervades the school. (p. 332)

Other characteristics were also identified in terms of teacher interactions and participant qualities. The most successful schools exhibited and encouraged frequent discussion of teaching practices and the sharing of teacher knowledge. The interactions were seen as "reciprocal," meaning that ideas, as well as arguments, were debated professionally. Within the successful schools, a participant's formal or informal status impacted the influence of the relationship, as well as the participant's knowledge and skill, and role competence. Overall, the research identified the workplace as "extraordinarily powerful" (p. 338), where the greatest potential for influence was a staff development program that promoted a culture of collegiality (Little, 1982).

The final selected research study by Horn and Little (2010) investigated how "teacher talk" and collegiality influenced professional learning within two urban high schools. Over a 2-year period, the researchers studied two subject department groups,

The Algebra Group and The Academic Literacy Group, to “determine what such in-depth interaction, mutual support, and professional learning might entail” (p. 185).

The discussion centered on the use of “teacher talk” to promote or discourage professional learning. The researchers used the term “normalizing” to refer to teacher responses that indicate this is a ‘normal situation’ and “it happens to all of us” (p. 192). Two different outcomes occurred when normalizing practices were analyzed. The conversations either turned ‘toward’ the teaching or ‘away’ from the teaching practices. Moving ‘toward’ the teaching practice meant that the conversation went from specific classroom problems to a discussion of general problems and finally to opportunities for teachers to learn about practice and teaching principles. Horn and Little (2010) described this deeper discussion as “focused reflection” (p. 194). The teachers in the Algebra Group were able to generate “theories of teaching” by connecting “abstract” teaching ideas to specific classroom examples (p. 200). This is comparable to the research of Cohen and Ball (1999) when they emphasized the link between professional learning and practice.

The second outcome of moving ‘away’ from the teaching meant that the practice of normalizing limited teacher’s professional talk. Rather than reflecting and discussing problems that occurred, time restraints often meant that for the Academic Literacy Group, a ‘show and tell’ method was adopted. In separate interviews, teachers admitted that they had not collaborated as much as they had hoped (Horn & Little, 2010).

Both groups were focused on improvements in teaching and learning, however, significant differences in how they shared professional “talk” of practices, leadership within their departments, and their stage of curriculum development impacted their

professional learning. The Algebra Group had two co-chairs in their department who succeeded a very experienced and successful department chairperson; their curricular resources had been “located, selected, revised, or designed” by the group and provided a solid foundation for handling instructional problems, as well as student comprehension problems. The Academic Literacy Group’s leadership, however, was set up by grade level and characterized as a “division of labor,” who provided only “modest support for teachers” (p. 211). While it may be viewed as a distributed leadership style, the teachers that took active roles often developed lessons and then used a “showing” and “telling” scenario, rather than “collective deliberation” (Horn & Little, 2010, p. 211).

Horn and Little (2010) argued two reasons for implications on further research. First, the desire for collaboration and sharing may be necessary for improvement, but it is not enough to always generate professional learning. Both The Algebra Group and The Academic Literacy Group had quite different approaches to the problems and practices that surfaced. These differences affected the teacher’s understanding and professional learning. Second, the “conversational routine” that occurs within the collaborative group determines the learning potential of the group. The two groups studied did not differ in their feelings towards improvement and their responsibilities for student success, or the time they spent with each other. However, they did differ in the “nature” of their conversations (p. 212).

The research by Horn and Little (2010) provides a glimpse into the struggles and achievements of two subject departments, within the same school, that were committed to improvement. By comparing and contrasting the two departments, the researchers provided evidence of how the math department, focused on ninth grade algebra, used

collegiality, leadership, and discussion to successfully provide professional learning experiences to members of its department. The data collected provided a realistic look at the informal teacher talk and interactions that occur on an everyday basis within subject departments. This teacher talk, that occurs in hallways, lunch rooms, work rooms, and other classrooms, will either provide learning experiences or not, depending on how other teachers respond, share, and deliberate their professional practices.

The relative significance of both studies, Little (1982) and Horn and Little (2010), is their focus on teacher learning. In both studies, the successful school or the successful department built opportunities for professional learning; teachers were willing to listen and help one another. The focus on practice and shared knowledge, as well as the informal instances of learning give meaning to collegial relationships that are not based on formal roles, formal staff development, or other hierarchical measures. The research of both studies gives a better understanding to the idea of professional and adult learning in a social environment.

Chapter Summary

The research on teacher leadership has fluctuated over time, often increasing when school reform measures are heightened. This emerging form of leadership has the potential to affect teacher learning, student learning, instructional improvement, and overall school improvement. Therefore, as a component of school reform, teacher leaders are a direct link between the external influences on education and the teacher's classroom. Research on distributed leadership was presented by Gronn (2002) and by Spillane (2004), which provided the framework for teacher leaders to emerge, depending on situation and knowledge. Leadership is about influence, as defined by Northouse

(2004), and influence is exercised when trusting relationships are built. For teacher leadership to be successful, the interactions and collaboration between colleagues is essential. Little (1985), Miles et al. (1988), and Smylie et al. (2007) addressed the skills and trust needed for such collaboration.

Teacher leadership is connected to teacher's professional learning. The research of Little (1982), of Darling-Hammond and Bransford (2005), and of Horn and Little (2010) provided investigations into successful schools and professional learning where teachers talk about their problems, their practice, and their limitations. A report on the status of professional learning in the United States was presented. While some schools are making progress in this area, there is much to be done with improving professional learning.

In particular, subject departments at the high school level offer teachers the opportunity for leadership roles, collegiality, and learning. The natural boundaries that are created by departments and the commonality of subject matter offer teachers content knowledge, as well as pedagogical knowledge. Siskin and Little (1995) and Harris (2000) presented research on how subject departments give rise to formal and informal leadership roles, while Scribner and Bradley-Levine (2010) addressed the social experiences and societal influences on teacher leader roles.

The review of literature presented teacher leadership as a link to teachers' professional learning and collegiality in subject departments. Specific research was presented on mathematics departments and mathematics reform influences. As schools embrace a distributed leadership style, top-down administration will be replaced with teacher leaders. It is important for administrators, teachers, and teacher leaders to

understand their roles as schools face unprecedented hardships and obstacles. To improve mathematics education, and education overall, it is necessary to continue the cycle of research and reform.

Chapter 3: Methodology

Study Design Overview

The purpose of this qualitative study was to understand professional learning and teacher leadership in a secondary mathematics department. Researchers (Ball, 2002; Elmore, 2004; Fullan, 2007; Guskey, 2002) suggest that teachers need opportunities for on-going professional learning that is related to their day-to-day practices and classroom instruction, rather than whole-school workshops, in-service programs, and lectures. In an effort to understand how teachers can learn from one another, in a subject department setting, as well as have leadership opportunities, an ethnographic design was chosen for this study. Ethnography is often used to understand cultures or sub-cultures. In this case, the teachers within the mathematics department made up a sub-culture of individuals. This research was guided by the following questions.

1. What does teacher leadership look like in a selected secondary mathematics department?
2. What are the formal and informal roles of leadership within this secondary mathematics department?
3. How do teacher leaders in the department create opportunities for professional learning?
4. How do teachers experience professional learning in this selected secondary mathematics department?

Qualitative Research

Qualitative research relies on a “holistic description” of a particular situation, phenomenon, or activity (Fraenkel et al., 2012, p. 426). A defining attribute of qualitative data uses words and rich description, rather than numbers. “Words, especially organized into incidents or stories, have a concrete, vivid, meaningful flavor, that often proves more convincing to a reader...than pages of summarized numbers” (Miles & Huberman, 1994, p. 1). To achieve this level of understanding, qualitative research employs several unique procedures that set it apart from quantitative research. Some of these characteristics include: the research is done in the natural setting; data collection methods vary, but usually include in-depth interviewing, observations, and document analysis; the research is “emergent” rather than hypothesized; the research is interpretive, seen through the researchers’ personal lens; the process of data analysis focuses on reoccurring themes using “inductive and deductive processes”; and, qualitative research uses several different strategies to guide this study (Creswell, 2003, p. 183). This chapter presents the research design and methodology for this study.

Ethnography is used in qualitative research when the intent is to understand the culture of a select group of individuals. The focus of ethnography is not on a specific issue, rather, it is on understanding how the culture interacts, socializes, and shares commonalities. Little (1982) used focused ethnography to better understand collegiality and teacher learning that evolved through the social organization of the school setting. During the 19-week investigation, the research by Little (1982) used interviews and observations across six schools in an effort to understand how formal and informal occasions give rise to teachers’ “learning on the job” (p. 325). Similarly, Hunzicker

(2010) combined ethnography and comparative case study designs when investigating teacher learning that occurred through the National Board certification process.

Ethnography is interpreting the shared beliefs, language, behaviors, and values of a “culture-sharing group” (Creswell, 2007, p. 68). Therefore, understanding how teachers learn professionally and how leadership emerges amongst teachers in a mathematics department can best be described using an ethnographic approach. The process of ethnographic research involves frequent, long-term observations of the group, known as fieldwork, allowing the researcher to become “immersed” in the culture. Participant observation is used as a way of understanding the day-to-day activities and norms of the group. Ethnography requires a “sensitivity” and respect of the daily interactions that take place within the group; ethical considerations are critical to forming relationships between the researcher and the participants. Murphy and Dingwall (2001) stated:

Like all research that involves human participants, ethnography raises significant ethical concerns. All researchers share the same minimal responsibility to protect participants from harm even where such participants may, themselves, be cavalier about the risks they are taking. (p. 347)

Role of the Researcher

One of the challenges of ethnographic studies is that the researcher brings their own world-views, paradigms, and biases to the research study, leaving the data collection and analysis open to subjective interpretation. In the early 1970s, the question posed by several researchers was, “could social science methods, no matter how carefully done, generate objective data?” (Heyl, 2001, p. 372). While it is difficult then to separate the

“personal-self” from the “researcher-self,” qualitative studies represent “honesty and openness,” creating the humanistic approach to research that quantitative studies lack (Creswell, 2003, p. 182). To address the concerns of reflexivity—which represents the researcher’s world-views, values, and biases—acknowledging them ahead of time helps clarify the personal lens used in this study (Creswell, 2003).

There are certain assumptions and biases that the researcher brings to this study. As a previous mathematics teacher in a secondary department, the assumption that informal professional learning does occur through teachers helping one another and professional dialogue is a result of the experiences of the researcher. The researcher has spoken a number of times with another math teacher, teaching the same subject matter, who was able to provide both content and pedagogical knowledge that influenced the researcher’s practice. Thus, the researcher felt that if the culture of learning in the department can be understood, perhaps more effective ways can be found to encourage and develop this type of learning from colleagues. The researcher has also been subjected to formal professional development programs at the school that have done little to improve either the subject-matter knowledge or pedagogical knowledge that is needed at the classroom level, therefore, reinforcing the need for informal opportunities for teachers to share ideas, subject-area expertise, and best practices.

Most of the teachers within this school’s math department have specialized knowledge in some area and may benefit from having leadership opportunities in these areas. Two teachers have in-depth training with graphing calculators; one teacher is proficient with *Autograph*, and one teacher is proficient with *GeoGebra*—two graphing software programs; and one teacher has extensive training in professional learning

communities. Thus, the assumption that professional learning and teacher leadership are two important components that may affect teachers' practices' is grounded in the researcher's personal experience as a previous member of the department. Currently, the researcher is in the role of interim principal for the school. This position, while completely unexpected at the start of this study, provides the realistic opportunity to influence teacher learning and leadership.

Sample

A characteristic of qualitative research is the use of purposeful sampling. Creswell (2007) described this approach as selecting sites and individuals that will best inform the study and answer the research questions. Ethnography relies on a single site where a "culture-sharing group has developed shared values, beliefs, and assumptions" (Creswell, 2007, p. 122). A list of possible sampling parameters for this study is provided (see Appendix A).

Demographics. The site, located in the State of Florida, is a 4-year private, parochial high school. Students are drawn from a 15-mile radius that reaches north, south, east, and west. The high school has a student enrollment of 530. The school prides itself on a 50-year tradition of academic excellence with 99% college matriculation, athletic accomplishments, and service outreach to the local community.

There were two reasons for selecting a private-parochial high school versus a public high school. First, the researcher has experience in the private sector at the secondary level and wishes to remain in private education. There are different requirements and expectations in a private high school, ranging from standardized testing to the way students are educated. These differences are apparent in the curriculum,

accountability issues, funding, parental support, as well as many other areas. Therefore, having an understanding of how professional learning and leadership evolve in private versus public high schools may have very different outcomes. The second reason for choosing private over public education was due to time and convenience. Table 5 presents the demographics of the math department faculty.

Table 5

Demographics of the Math Department Faculty

Faculty Member Pseudonym Gender Ethnicity	Years of Teaching Experience	Years of Teaching Experience at this School	Subjects Taught	Grade Levels
Mike Male White	12	12	Calculus Probability & Statistics Physics	11–12
Grace Female White	13	13	Algebra I Algebra II	9–11
Sunshine Female White	36	34	IB Math Algebra II Honors Learning Strategies	9–12
Eileen Female White	12	12	Geometry Geometry Honors Financial Algebra	9–12
Jane Female White	18	10	Pre-Calculus Honors Pre- Calculus IB Math Algebra II	10–12

The members of the math department bring an extensive amount of experience to the school. Three out of five members have taught only at this school; all five members have over 10 years experience at the school. The most experience is 36 years.

Access. To gain access to the institution, ethnography typically employs entry through a “gatekeeper,” an individual who has close ties with the cultural group being studied (Creswell, 2007, p. 71). The department chair, or gatekeeper in this case, was contacted in person to inquire if the teachers would be open to the research study being conducted at the school. Once the department chair gave verbal approval, the researcher contacted the president of the school and the school superintendent. A meeting, in person, was arranged with both and the research topic and timeline were discussed. Once permission was been granted by the president and superintendent, the researcher sent each teacher within the department an introductory letter (see Appendix B) asking for their participation. The teachers were asked to sign the consent form and place it in the researcher’s mailbox in the teacher’s mailroom. Once all consent forms were signed and returned, the researcher set up dates for the first set of interviews.

Data Collection

Three types of data collection were used for this ethnographic study: interviews, both open-ended and semi-structured; participant observations; and documents and artifacts including meeting agendas, teachers’ course syllabi, and any training material. Prior to the interview, each teacher in the department was asked to complete an information sheet (see Appendix C). Data were collected from September, 2012, to April 1, 2013.

Interviews. Ethnographic interviewing has deep roots in anthropology, whose interviewing techniques were traditionally done on-site during “lengthy field studies” (Heyl, 2001, p. 369). Much has been written about the benefits and challenges of

ethnographic interviewing by Heyl (2001) in her review of literature. She defines ethnographic interviewing as:

Those projects in which researchers have established respectful, on-going relationships with their interviewees, including enough rapport for there to be a genuine exchange of views and enough time and openness in the interviews for the interviewees to explore purposefully with the researcher the meanings they place on events in their world. (p. 369)

A series of three continuous, in-depth interviews were used in order to gain the meaning of professional learning and leadership opportunities within the selected math department. Heyl (2001) describes the researchers job in ethnographic interviewing as the need to “communicate genuinely, in both subtle and direct ways that ‘I want to know what you know, *in the way that you know it...*’ Will you become my teacher and help me understand?” (p. 369). To do this, Heyl makes four recommendations:

1. Listen well and respectfully, developing an ethical engagement with the participants at all stages of the project;
2. Acquire a self-awareness of our role in the construction of meaning during the interview process;
3. Be cognizant of ways in which both the ongoing relationship and the broader social context affect the participants, the interview process, and the project outcomes; and
4. Recognize that dialogue is discovery and only partial knowledge will ever be attained. (p. 370)

In order to facilitate the interview process, an interview guide (see Appendix D) was used to help gather the data. The interviews were semi-structured to start, with open-ended questions. In ethnographic studies, interviews are mostly informal in order to establish a comfortable, friendly manner, “they require neither any particular type of question nor any particular sequence in which questions must be asked” (Fraenkel et al., 2012, p. 512). Miller (2008) reported that in-depth interviews were used to gain an understanding of the participant’s views and perceptions regarding problem-based conversations. Hunsicker (2010) used interview guides and semi-structured interviews that targeted “beliefs, values, and attitudes about teaching and learning, professional practices...and experiences during National Board candidacy” (p. 3).

Each participant was given confidentiality and provided a pseudonym so that readers are better able to connect with the experiences and thoughts of the participants. Each interview was audio-taped with permission and conducted face-to-face at the school site at a time that was convenient for each participant. Three semi-structured interviews were planned for each teacher in the department, during the beginning of this study, midway, and towards the end. Informal, spontaneous interviews at the site were used on a continuous basis when appropriate. One of the defining characteristics of ethnographic interviewing is the building of relationships between the researcher and the participants. Heyl (2001) states, “the significant time invested in developing, through repeated contacts and multiple interviews over time, a genuine relationship involving mutual respect...evolves” (p. 379).

Participant observations. Ethnographic fieldwork includes the use of participant observations. Emerson, Fretz, and Shaw (2001) describe this type of observation as,

“establishing a place in some natural setting on a relatively long-term basis in order to investigate, experience, and represent the social life and social processes that occur in that setting” (p. 352). Fetterman (1989) says that participant observation “combines participation in the lives of the people under study with maintenance of a professional distance that allows adequate observation and recording of data” (as cited in Fraenkel et al., 2012, p. 512). Hunzicker (2010) used extended observations in a natural setting, a characteristic of ethnographic research, using “descriptive notes” and a “narrative style” to obtain a realistic picture of teacher learning (p. 3). Further, Horn and Little (2010) used participant observations in their research of the Algebra Group and the Academic Literacy Group. Unexpected openings in both departments allowed two of the three researchers to become members of the department with part-time teaching assignments. This particular experience, while uncommon, did provide the researchers access to “insider” information and meanings that, otherwise, may not have been visible. Because of the shared experiences now, the teacher participants reported “being more frank and open with the researchers” (p. 188).

To become immersed in the culture requires the researcher to commit enough time to the community under study so that the researcher is able to “internalize the basic beliefs, fears, hopes, and expectations of its people” (Fraenkel et al., 2012, p. 512). The data collection process took approximately 7 months of fieldwork. A Field Note Guide (see Appendix E) was used for participant observations that were done at random times throughout the course of this study. An Observation Guide (see Appendix F) was used for observations that occurred when teachers were in department meetings, the faculty lounge, mailroom, and during the school in-service professional development programs.

Participant observation involves “not only gaining access to and immersing oneself in new social worlds,” but also writing a written account of these experiences (Emerson et al., 2001, p.352). Field notes are an account of the “day-by-day” activities, “observations, and reflections” that are produced “in or close to the field” (Atkinson, 1992, as cited in Emerson et al., 2001, p. 353). As a result, these notes are subjective to the researcher’s personal lens:

As representations, field note texts are inevitably selective. The ethnographer writes about certain things that seem ‘significant,’ ignoring and hence ‘leaving out’ other matters that do not seem significant. In this sense, field notes never provide a ‘complete’ record. But, field notes are also selective in what they do include, since they inevitably present or frame the events and objects written about in particular ways. (Emerson et al., 2001, p. 353)

Field notes have two other distinctive characteristics. They are descriptive; it is not a matter of merely recording the facts, but the writing must reflect “particular purposes and commitments,” and field notes are part of a larger “corpus”; researchers collect day-to-day writings that contain “bits and pieces of incidents, beginnings and ends of narratives” knowing that not all the information gathered in this “corpus of field notes” will be used in the final report” (Emerson et al., 2001, p. 353). There is a lack of consensus from ethnographers as to what constitutes ‘field notes,’ when they should be written, and the actual ‘value’ of the field note itself. Bogden and Biklen (2007) defined field notes as “a description of people, objects, places, events, activities, and conversations. In addition, as part of such notes...ideas, strategies, reflections, and hunches, as well as note patterns that emerge” (p. 118). Some of the conflicting practices

are: field notes may consist of quick notes jotted down, proper field notes, diaries, reports, letters, or journals; the writing of field notes may occur in the field directly when the incident is occurring, soon after, or upon leaving the site; and, the actual value of writing field notes lies anywhere in between those who feel that field notes are the “core of the ethnographic project” and those who feel “putting too much effort into writing field notes interferes with the fieldwork,” and still others who feel that “field notes simply cannot capture the depth and subtlety of the ethnographer’s intellectual and personal encounter with others’ ways of living” (Emerson et al., 2001, p. 355).

Fraenkel et al. (2012) suggested there is a difference between field notes, field jottings, field diaries, and field logs-each used for a specific purpose in the field. Bogden and Biklen (2007) referenced the “descriptive” and “reflective” nature that field notes should consist of (p. 120). These are the problems, challenges, and recurrent questions that ethnographic field notes present, and since access to a researcher’s field notes is limited, if ever seen, “it is often difficult to determine the reliability of the researcher’s observations” (Fraenkel et al., 2012, p. 512).

One final concern that is addressed by Emerson et al. (2001) in regards to the field notes is the sensitivity, trust, and privacy that must be adhered to while in the field. While most participants are expecting the researcher to take notes, the actual act of doing it in their presence can change the relationship:

Ethnographers often experience deep ambivalence about whether, when, and how to write jottings. On the one hand, the ethnographer may wish to preserve the immediacy of the moment by jotting words as they are spoken and details of the

scenes as they are enacted; on the other hand, he may feel that openly writing jottings may ruin the moment and plant seeds of distrust. (p. 357)

Bogdan and Biklen (2007) suggest being discreet; make sure “that anything you put down on paper is material that you would not mind your subjects seeing” (p. 99). To protect the participants of this study several steps were taken: (a) anonymity was provided to each participant through the use of a pseudonym, (b) written permission was received from each participant to proceed with this study, (c) approval from the Institutional Review Board by the research institution was received, (d) the participants were informed prior to data collection procedures using tape-recordings, (e) transcriptions were returned to the participants for verification, and (f) the participants’ interests were considered first in all matters regarding reporting sensitive material.

Documents and Artifacts

Documents are another form of data collected in qualitative research. In an effort to understand the culture of the group studied, documents may provide insight into the culture’s norms, beliefs, and way of life. Bogden and Biklen (2007) define documents as, “materials such as photographs, videos, films, memos, letters, diaries, clinical case records, and memorabilia of all sorts” (p. 64). Furthermore, they state three main types of documents to consider: personal documents, official documents, and popular culture documents.

Documents were used that reflect the culture of the mathematics department, such as agendas for department meetings, teachers’ course syllabi, professional development material, the school’s mission statement and philosophy, and teacher correspondences, if appropriate (see Appendix H). The quantity of documents and materials, the length, and

the amount of content, require researchers to clarify and summarize the data for better analysis and efficiency (Miles & Huberman, 1994). The Document Summary Form (see Appendix I) was used to review and record any significance the document had related to this study, and a brief summary was written and attached to each document.

Data Analysis

The data analysis process for ethnography involves identifying key themes or patterns that emerge from the interactions and socialization within the culture. Fraenkel et al. (2012) feel that the data analysis process actually begins “from the first moment a researcher selects a problem to study,” and ends when the “final report is written” (p. 516). Three forms of data collection were used in this study: in-depth interviews, observations, and documents. Creswell (2007) recommended that the data analysis process, for an ethnographic study, consist of: “description, analysis, and interpretation of the culture-sharing group” (p. 161). Detailed description is important in developing the “story” about the culture group, and plays a “central role in ethnographic and case studies” (Creswell, 2007, p. 151). Wolcott (2009) described the difference between analysis and interpretation. Analysis follows standard procedures that are rigorous and methodical; Wolcott advised, “when you do turn to analysis, make that dimension of your study as strong and systematic as possible” (2009, p. 31). In contrast, interpretation uses a more humanistic approach, allowing for “human activity that includes intuition, past experience, and emotion” (Wolcott, 2009, p. 30).

The data analysis process followed the six steps, suggested by Creswell (2003). First, recorded interviews and meetings were transcribed; field notes and documents were prepared for analysis. The first read-through of the data used initial coding (Appendix

G), and then a more in-depth analysis and coding process was completed (Appendix G) for the second and third read-throughs. Miles and Huberman (1994) discussed the importance of understanding patterns, recurrences, and the “plausible whys,” just naming what the data are, is not enough (p. 69). Relevant teacher statements and other data were organized into “chunks,” using index cards. Next, significant themes were identified and a detailed description of the setting, including the “people, places, and events,” was written. Finally, the interpretation of the findings, as compared with the literature from Chapter 2 was presented (Creswell, 2003, pp.191–194). The goal of the final report was to “paint a portrait” of the group that gives meaning to the activities, norms, and values as seen through both the views of the participants and the views of the researcher (Fraenkel et al., 2012, p. 512).

Reliability and validity. The researcher validated the accuracy of the findings using several procedures: (a) triangulation used different forms of data sources to compare common themes, (b) member-checking was used to confirm the transcriptions verbatim, (c) “rich, thick description” conveyed the setting of the study and project an “element of shared experiences” with the reader, and (d) the role of the researcher, including any bias and personal views, was disclosed (Creswell, 2003, p.196).

Triangulation establishes validity by comparing the findings through several data collection methods, such as-participant observations, interviews, and document analysis. By locating similarities, triangulation supports and gives credibility and “accuracy of the researcher’s interpretations” (Fraenkel et al., 2012, p. 517). Member checking involves returning the transcribed data, analysis, and interpretations to the participants to check the truthfulness of the researcher’s account. “This technique is considered by Lincoln and

Guba (1985) to be ‘the most critical technique for establishing credibility’” (as cited in Creswell, 2007, p. 208). The use of “thick, rich description” provides the reader detailed descriptions of people, places, and events so that the reader is able to “transfer information” throughout the narrative, determining if the findings are accurate based on “shared characteristics” (Creswell, 2007, p. 209); and finally, clarification by the researcher in regards to any biases, judgments, or previous experiences that may influence the findings of this study was disclosed to enhance the validity.

Chapter Summary

This qualitative study used an ethnographic design to understand how teachers in a secondary mathematics department use teacher leadership and professional learning to affect their practice. Ethnography is used to understand how a specific culture interacts, socializes, and shares commonalities within a natural setting. Fraenkel et al. (2012) stated that a key strength is the “comprehensive perspective” that ethnography provides over other forms of research used in education (p. 520). The data collection methods for this study used in-depth interviewing, participant observations, and document analysis in an attempt to answer the research questions guiding this study.

Data analysis procedures involved six steps, suggested by Creswell (2003), that included preparing the data for analysis, a thorough reading of the data using initial codes, followed by a more in-depth coding process, identification of key themes and patterns, writing a detailed description, and then presenting the findings and researcher’s interpretations as compared with the literature presented in Chapter 2. The role of the researcher was presented to establish any biases, arguments, and prior experience the

researcher brings to this study. Other forms of validation included triangulation, member-checking, and thick-rich description.

The theoretical frameworks of this study—adult learning theory, social learning theory, and distributed leadership theory—were used to systematically identify patterns and themes during the analysis process. The final report reflects the values, beliefs, and cultural norms of the teachers within the selected mathematics department.

Chapter 4: The Story

The Setting

From a distance, the high school blends into the surrounding buildings and architecture. Situated between a church, apartment buildings, and a shopping center, the school grounds deceptively hold four athletic fields, a gymnasium, cafeteria, weight room and locker rooms. Additionally, there are two main buildings on the 32-acre campus that house the classrooms and administrative offices. The two-story classroom buildings are connected with a covered breezeway, often providing a popular gathering spot for the students before and after school.

The grounds and exterior of the buildings are kept up as best as possible; it isn't until one sees the window air-conditioners extending from each classroom and the louver shutters that signs of the 50-year old school become visible. A small building to the north of the classrooms is used for meetings, additional offices, and alumni gatherings. The old restrooms and bedrooms on the second floor of this building, as well as the kitchen on the first floor, serve as a reminder of earlier times when the school was staffed and run by a religious order of priests.

The Teachers

The participants in this study were five high school math teachers. The five teachers of the math department bring an extensive amount of experience to the school and are considered veteran teachers. All have over 10 years of teaching experience at the

school; together, they have over 91 years of teaching experience. Each teacher brings something unique to the math department.

Eileen. Eileen has over 10 years teaching experience at the school and would be considered the newest member of the department, other than the researcher and current principal who was also a math teacher at the school for 8 years. After watching her father, working as an education professor at the same college she attended, Eileen toyed with the idea of becoming a teacher. It wouldn't be until after a period of time in the business world that she would seriously look at education again. Unhappy with her sales job at the time, Eileen applied for and got a teaching position in the math department at the high school. Her years of education classes, as well as business and math courses helped secure a position teaching geometry, which has become her strength and love.

If it is 7 a.m., Eileen will most likely be walking through the school doors. Her punctuality is carried over into the classroom as well. The students know that the beginning of each class will always be the same. Eileen's "5-minute checks" have become a standard in the department. The students also know that she will enforce the school rules, especially the one about tucking in your shirt. To the outsider, Eileen may appear strict; however, her knowledge, confidence, and compassion can be seen in the many times she stays after school to help students, or returns in the evenings to watch students compete in athletic events, or the times when other teachers go to her for help. When no one else would help the cross-country coach, Eileen was out there in her shorts, t-shirt, and hat coaching and supervising the kids, because she knew that was the right thing to do.

Administration relies on Eileen as well. Because of her organizational abilities, work ethic, and people skills, Eileen was asked, with several other teachers from the school, to lead the development of Professional Learning Communities among the seven academic departments. In addition, she was given the responsibility of textbook inventory, collection, and distribution for the coming school year. Eileen has always enjoyed learning, even “sitting in a class.” She says that now though, learning needs to be “hands on” for her, and she becomes easily frustrated when she feels her time is wasted. In response to a faculty in-service opportunity on a new computer program, she said, “It drove me insane that they wouldn’t actually let us do something, especially when you’re sitting in front of a computer screen!”

While the two buildings provide a physical separation for teachers, Eileen would like to see more of the faculty work together. She would like to change, what she calls, a feeling of “compartmentalization” in the school, “You don’t see the people in the other building. We don’t even see the people downstairs very often, so it would be good if we had some time to come together.” Teamwork and a sense of community are important for Eileen. She sets high expectations for her students in a strict, but caring, manner. She enjoys leading by example and doing the best job possible. A concept map, presented in Figure 1, displays Eileen’s statements and beliefs regarding teacher leadership and professional learning.

Eileen

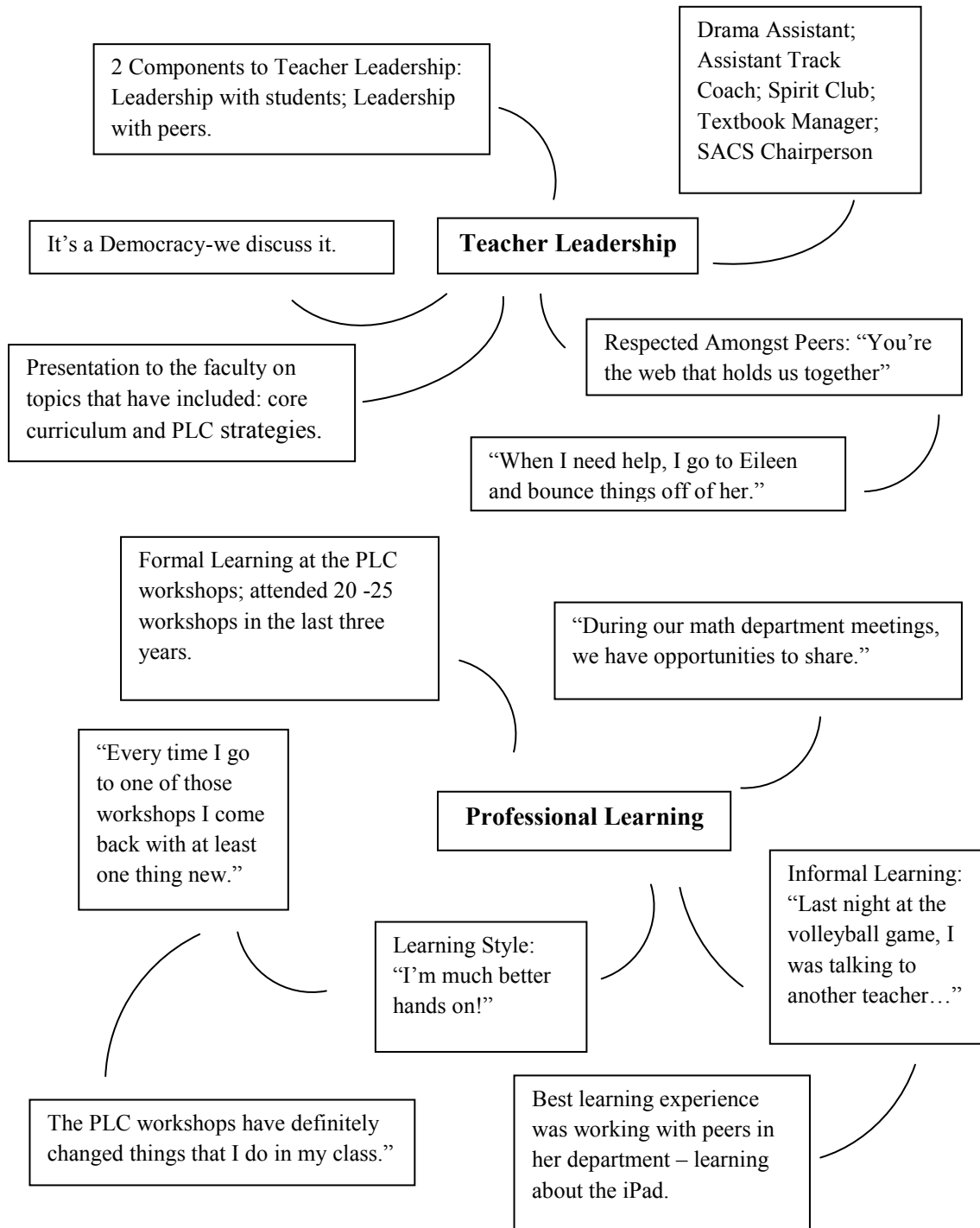


Figure 1. Concept map: Beliefs and statements about teacher leadership and professional learning for Eileen.

Sunshine. Sunshine brings over 35 years of teaching experience to the department. Growing up, she says, “I was the oldest of five children and I was kind of like the mother-hen type.” Teaching seemed a natural profession with teachers on both her mother’s and father’s sides of the family. After finishing her studies, there was a hiring freeze in her county, so Sunshine set her sights a little to the north and was hired at the high school; and this is where she has remained.

Sunshine teaches five courses this year that include both higher and lower level students in mathematics and one religion course. She loves teaching at the high school and feels very fortunate being able to share her faith with students, “If I were in a public school, I couldn’t address the spiritual education at all, and I would find that very hard.” Daily mass in the school chapel is a part of Sunshine’s morning routine. She is also responsible for training the Eucharistic Ministers and lectors for the school liturgies. As part of the training, Sunshine teaches the students about serving their community; she takes several field trips each year to the nearby nursing home. Another area of importance for Sunshine is her responsibility to oversee the blood drives held at the school. Just before each blood drive, she visits classrooms to make sure that students understand the importance of giving blood and saving lives.

Sunshine has worked with struggling students in mathematics for many years, and she credits much of her learning to Dr. C, “All students aren’t the same and trying different techniques with different students can help them to be very successful.” Having that opportunity with Dr. C, 15 years ago, really opened her eyes to the challenges and struggles that students have learning. Many of her planning periods are spent calling parents, speaking with the school psychologist and guidance counselors, and working

closely with the teachers of her struggling students. Her patience and compassion for others is a gift; she rarely speaks an unkind word, which is a testament to her faith.

Technology is an area that Sunshine says she wishes she knew more about, “When I heard that there are over 700,000 applications on the computer, I thought, ‘well no wonder I can’t keep up.’” The introduction of the iPad this year for teachers has been the most recent area of professional learning for Sunshine. As a faculty member at the school when computers were first introduced in the eighties, Sunshine remembers the novelty, “we had two and it was like a goldmine!” Upon her arrival to the school with a background in computers and mathematics, Sunshine taught computer programming at the school, recalling, “It was such a popular class, not because of me, but because of the innovation. We actually had to have a lottery to get into the class.” Now, Sunshine learns a lot from other teachers and her students in the way of technology. She has learned a few new things on the graphing calculator and how to navigate through the *GeoGebra* program. For her, teacher leadership is all about sharing “a good teaching idea.”

Some of the struggles that Sunshine faces, as most of the teachers in the department, are issues of time and stress that the job requires, “I get frustrated at times with trying to keep up with it all.” There are programs to go to, books to read, and a constant stream of e-mails that pull the teachers in different directions. Bringing it back into focus, Sunshine says she also wishes she had “more time to work with students individually.” She realizes that students need the individual attention, especially in mathematics. A concept map, presented in Figure 2, displays Sunshine’s statements and beliefs regarding teacher leadership and professional learning.

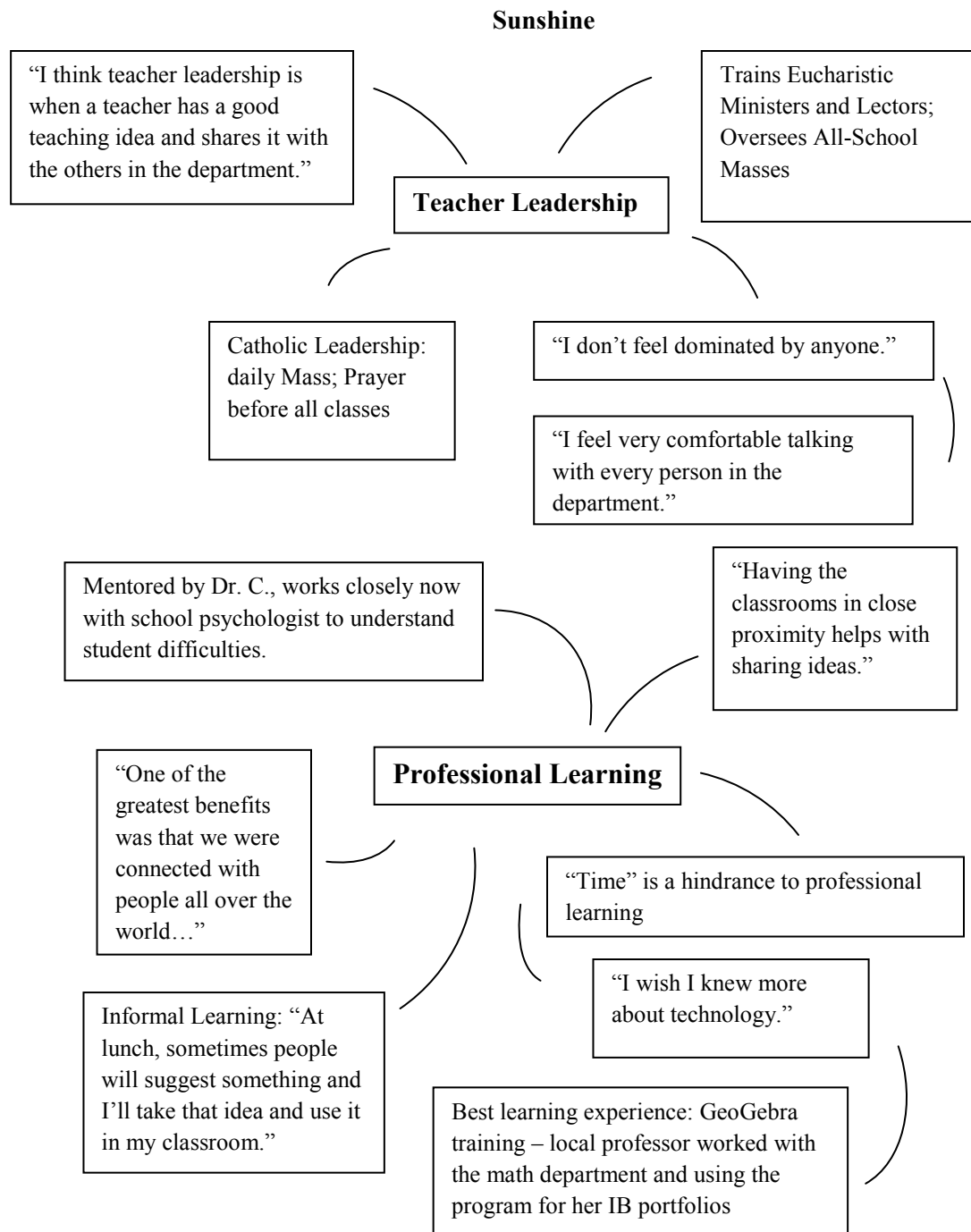


Figure 2. Concept map: Beliefs and statements about teacher leadership and professional learning for Sunshine.

Jane. After 8 years of teaching in the public schools, Jane was ready for a change. The bureaucracy of education and feeling a lack of administrative support made Jane realize that the change would either be into private education or an entirely different career move altogether. Ten years later, Jane is completely content with her teaching position, and other than the remote possibility of full-time tutoring, she said she would love to remain at the high school doing what she loves best-teaching math.

Jane's sense of humor and easy-going style set her apart from most other teachers. If it is laughter that you hear in the hallways, it's probably coming from Jane's classroom. She admits that she randomly moves the desks around, "just for fun," and then stands there and laughs at the chaos she has created for the kids. She loves trying new ideas, whether it is using choral response with the students or working with technology in the classroom. As a member of the Science, Math, and Reading Technology (SMART) initiative, a federally funded grant program focused on improving student learning through technology, Jane has had many opportunities over the past few years to learn about incorporating technology into her lessons. A requirement of the program is that Jane must attend professional development six times a year. Along with the iPad that she received from the school, she also received a MAC Book, digital camera, scanner, video camera, and an iPod from the grant program. Her goal this year was to make three iBooks and share them with the teachers in her department.

When she's not teaching, Jane likes to socialize with other teachers in the school, enjoying a good story or two. Laughing, she admits, "I go back and forth between the mailroom, looking for people to talk to, because, sometimes, I just need to get out and talk to an adult." Lunchtime is another favorite of Jane's. She enjoys the camaraderie of

her colleagues as they discuss the weather, their families, happenings at school, and just about anything else that comes up in conversation. Part of her easy-going, fun style is teaching the kids by singing songs. Jane feels that the song lyrics help the students to focus on learning, “I tell the kids, you keep singing the songs, they will get stuck in your head and you won’t forget the formula.” True to word, she explained that she has students return from college telling her that they are “still singing the Square Binomial Song.” As much as she does for the kids, Jane says they are the ones teaching her. Some of her best moments of learning occurred when students shared different things about the iPad, calculator, or iPad apps.’ “I love learning from the kids.” One of her more recent opportunities came when she explained that a student told her how to incorporate graph paper into the iPad app that she was using in class that day. She was so excited about this accomplishment, she said, “Dude, you are my favorite kid ever!” Jane experienced a lot of her learning, this year, through participating in the SMART program and through self-teaching. Jane is very fond of an interactive computer program—*GeoGebra*—that can be used for graphing and visual dynamics for all courses taught in the math department. When asked how she learned the program so well, she replied, “Oh, I played with it. I was so excited about it that I just kept playing around with it”

As much as she enjoyed “playing around with it,” Jane says that she also learns best when she has the opportunity of one-on-one learning, with someone “telling, helping, and showing” her and then, “having time to practice.” As the leader of the department, Jane struggles to see herself in that leadership role. She prefers to think of her duties as administrative-holding meetings and giving the teachers the latest information- versus one of coaching or teaching, “I don’t necessarily like being

responsible for everything, and I don't feel like I do the best job that someone can do.”

Aside from her personal feelings however, the teachers in the department are very happy with Jane's leadership style. A concept map, presented in Figure 3, displays Jane's statements and beliefs regarding teacher leadership and professional learning.

Jane

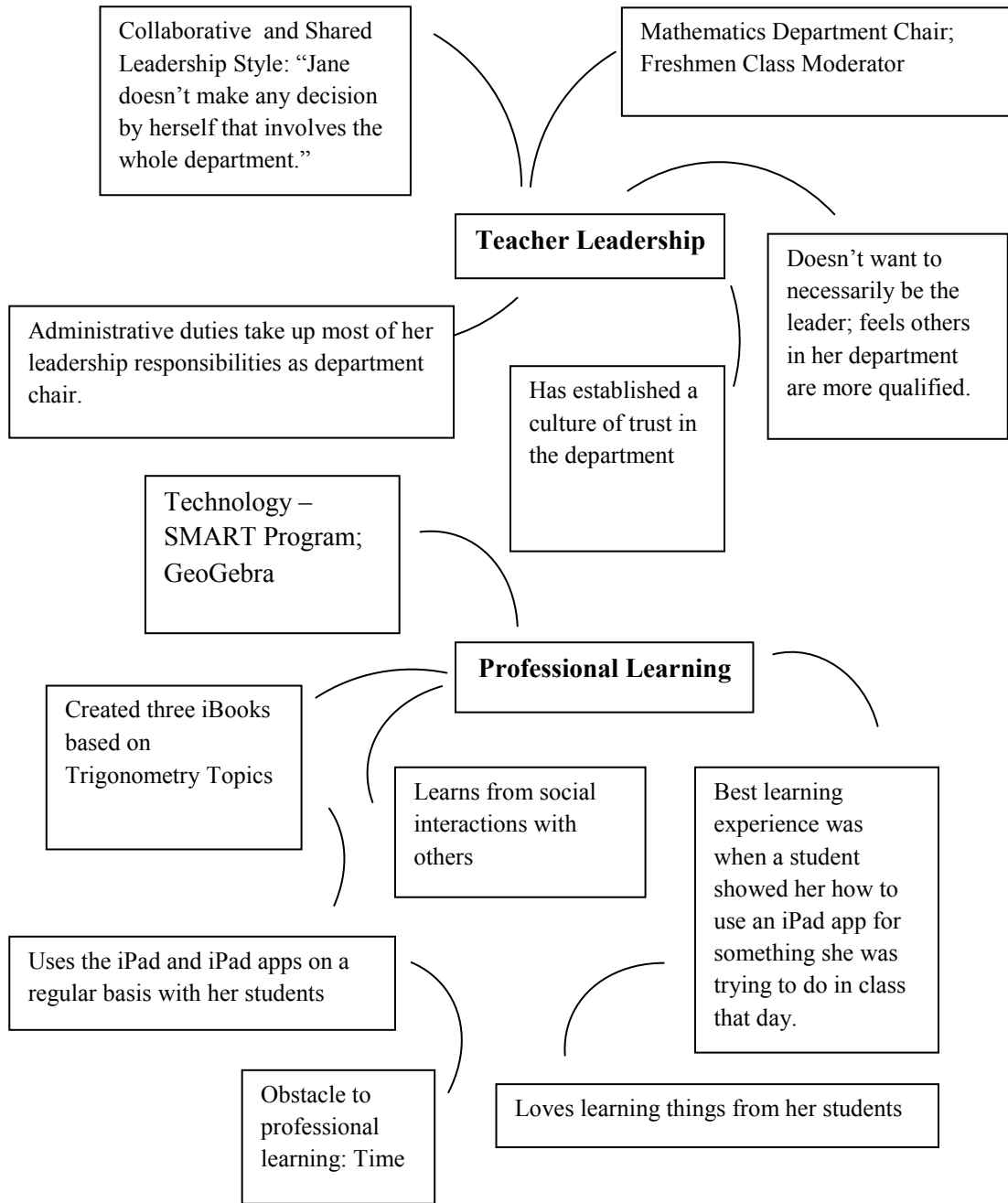


Figure 3. Concept map: Beliefs and statements about teacher leadership and professional learning for Jane.

Mike. Mike brings a wealth of life experiences to the department. His earlier careers in engineering, as well as his days as a naval officer explain the detailed routines and mathematical mind that Mike has. Teaching all upper level courses, Mike is proficient in calculus, statistics, and physics. These classes vary from the honors to the advanced placement levels. After retiring from his engineering career, Mike decided to substitute teach at the school for some side money, or as he put it, “golf money.” However, it wasn’t long before both he and the school administration were interested in making it a full-time teaching position.

One of the challenges that Mike faced this year was teaching five different courses, which meant he had, “five preps.” The stress level for Mike was extreme, so much so that when it came time to discuss next year’s assignments, Mike mentioned he may have to think about retiring if he was going to have the same schedule next year as this year. Another challenge Mike faced was incorporating the use of technology into his curriculum. Specifically, he mentioned his dislike for the iPad, “I don’t particularly like the iPad; I don’t find it to be useful. I have a keyboard for mine, but I still find it to be a cumbersome substitute for a computer.” Unfortunately with a back injury mid-way through the year, Mike thought that, perhaps, the iPad would help him use the whiteboard less, but when he went to focus his attention to the iPad, he realized that the school was not prepared yet with their own technology to support his needs. So, as he said, “I lost interest again, and I suppose that’s a little frustrating because I was really ready to go.”

Mike enjoys learning through reading and attending courses on the Advanced Placement curriculum. Having recently had the opportunity to attend workshops on the AP Calculus and AP Statistics, Mike was enthusiastic about the experience, “I was in

pretty good shape with the curriculum when I went to both of those and I still learned a tremendous amount.” As the only teacher in the department teaching his courses, Mike finds it challenging to go to his colleagues with questions, and instead prefers the formal setting of the AP institutes to learn from others. During one interview, Mike explained that, “the state of Texas sends their teachers back every 3 years” to these institutes. “Wow, in 3 years I could be so much better...I would have a better handle on what’s important and how they (the students) could learn it easier.”

Frustrated with his student’s learning, Mike spent time thinking about why his students aren’t able to perform at the level he wants; he explained, “I even talked it over with my wife.” He realized that it was through his own regimented practice of working the math problems over and over and over that made him successful, but “they’ve (the students) got too many other demands to practice anywhere near the level that I’ve ended up practicing.” His frustration was elevated by the amount of time that students were connected to their own technology devices. “You can’t keep adding to the pack with iPhones and iPads and twittering and tweeting and text messaging and so forth and put the same amount of time into your studies.” This realization helped Mike change his routine of homework assignments this year. He felt that having less problems to do each night, but doing them correctly, was far better than assigning many problems and having students do them all wrong, “if you practice doing the wrong thing, it doesn’t help you get better at all.” Mike found that by using the Khan Academy math videos, as supplements to his teaching, he was able to spend more class time helping individual students. Mike was the first teacher in the department to experiment with the concept of

the “flipped classroom,” and this was due in large part to the tremendous amount of time he spent over the summer preparing his lessons, using the Khan Academies.

Perhaps the most important accomplishment, Mike feels, is the focus he has placed on imparting his faith to his students. He feels very strongly that teacher leadership is about setting examples and evangelizing, “the most important person in a student’s life is the teacher and I think the example the teacher sets is the whole thing, relative to leadership.” Mike uses the art of story-telling to get the attention of the students, “I tell them a lot of stories, that probably don’t have an awful lot to do with math, but by the same token, I think they leave with something.” Mike is a leader with his faith, not only for the students, but for teachers as well. He is usually the first teacher to arrive for the 7 a.m. mass, lights the candles, prepares the readings, and starts a decade of rosary. His initiative in leading the rosary before each of the small morning masses led to a school-wide practice that was begun before each of the school masses that are held in the gymnasium. His latest effort in getting kids to understand the importance of faith in their lives came when four of his students decided, upon his urging, to attend the annual junior-senior retreat that is an optional, off-campus, experience. “I really pounded on them, saying they were fools if they didn’t go on that retreat;” for Mike, planting the seed of faith is very important. A concept map, presented in Figure 4, displays Mike’s statements and beliefs regarding teacher leadership and professional learning.

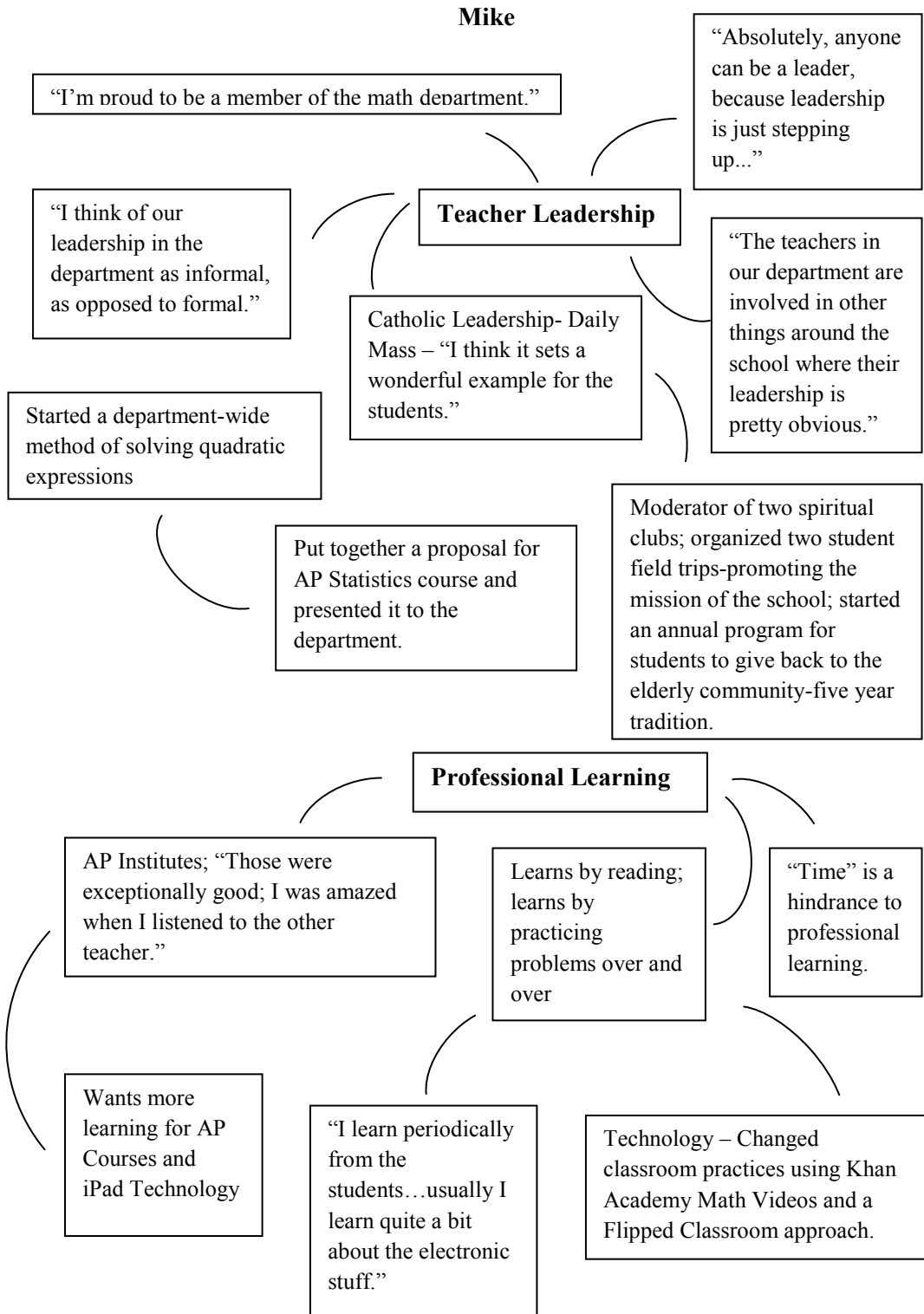


Figure 4. Concept map: Beliefs and statements about teacher leadership and professional learning for Mike.

Grace. Similar to Mike's story, Grace came to the school and the math department through unconventional routes. With her degrees in real estate, accounting, and computers, Grace embarked on a few jobs right out of college in these areas. However, she admits her gut instinct was telling her that maybe this wasn't something she would be doing "forever." With the influence of a close friend, Grace answered the school ad for an accounting instructor; she thought "what do I have to lose, let me try it." She explained that she was quite shocked when she got the job, thinking "I have no experience!" However, 14 years later, Grace is the department's strongest algebra I teacher and looking back, even though her first year was a "stressful year," she knew that this was what she was "called to do."

Grace enjoys teaching and working at the school, she said, "I have a passion for teaching and love what I do." She recalled that getting her certification in math was "the best decision ever." She not only enjoys teaching but she is open and eager to learn herself. This year she took the initiative to do some research on whole brain learning, "I think it's great for kids at the high school level because I think it breaks up the monotony." She admits to being guilty of getting stuck in the same routine, often lecturing, but she's noticing the recent focus in education on student learning and the movement towards the teacher as a facilitator, rather than lecturer. Grace learns through her peers and enjoys the collegiality, "I've come to realize, talking to my department head this morning, that just because you're used to doing things your way all the time, they're not necessarily the best ways...and I think because of the sharing, my teaching is better." Grace also had a couple opportunities to attend formal workshops off-campus, which she said has helped give her new ideas for the classroom. Sharing and "keeping a

willingness and openness” to learning is important for Grace. She and Eileen have formed a strong working relationship over time and they often exchange ideas, issues, and strategies between classes and during lunch.

For Grace, teacher leadership is about being a team player and setting a good example. Frustration is apparent when not all teachers do their part, “In the general sense, we all follow and enforce the rules, but when somebody else doesn’t carry their weight necessarily, it makes for a weak system.” The extra work increases the stress level for the teachers that pick up the slack, which in many cases, seems to be the teachers within the math department. Being in a private school also means, according to Grace, “being held to a higher moral standard” than other teachers. Grace’s classroom routine, she explained, typically begins with prayer, checking homework assignments, and having the “warm-up” problem ready on the board. She doesn’t neglect her responsibilities either; in fact, she feels “very strongly” that she needs to be present in her classes with her students.

One area that Grace is focusing on this year is learning more about whole brain learning. She described her initiative as, “a dynamic way of engaging the students.” Her research began with some of her elementary teacher friends using it and then with her taking “baby steps” in her own classroom, “When I tried it the other day, the students looked at me and thought I was crazy.” Grace said she would be visiting some websites and doing more research over her break in order to become more proficient using the strategy; she did promise that, “once I get up and running with it,” she would share with the rest of the faculty. A concept map, presented in Figure 5, displays Grace’s statements and beliefs regarding teacher leadership and professional learning.

Grace

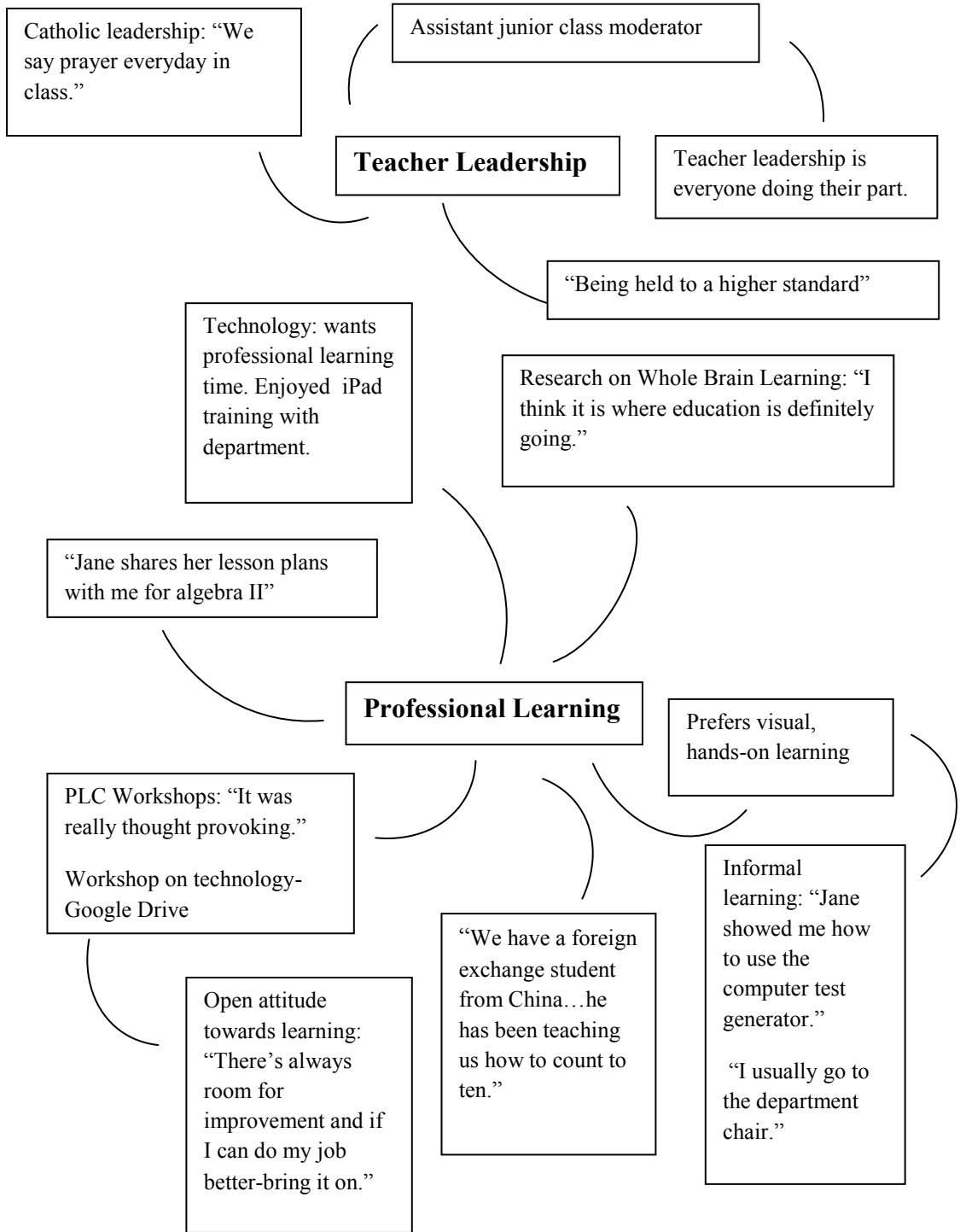


Figure 5. Concept map: Beliefs and statements about teacher leadership and professional learning for Grace.

Welcome to the Math Department

The clock on the wall read 7:13 a.m. when the door to the mailroom opened. Morning light was just beginning to stream in through the dusty window panes behind the copy machine. It was easy to tell that fall was showing all her signs of arriving as daylight came later, and the morning air had the slightest hint of chill. The well-lit room was a contrast to the looks on the faces of the few teachers that walked in. Maybe it was the early hour; maybe it was the thought of the workload ahead.

Eileen and Grace entered together, chatting as they walked over to the rows of tiny, wooden mailboxes that lined the wall. Each year the names are shuffled, ever so carefully, to account for those on staff who retired, or moved on, or sometimes, were asked not to return. This most recent year, there were a number of staff members, who after several decades of service to the school, choose to retire. One thing about this school-faculty, turnover is low. Of the 45 teachers on staff, about 90% have worked at the school more than 10 years. Eileen reached for the teabags atop the coffee machine, made her hot tea, and continued her conversation with Grace, who was fumbling through the papers she had retrieved from her mailbox. Most of the papers were photocopies she had requested the day before. Teachers are required to submit their photocopy needs 24 hours in advance to the main copy room, which sits adjacent to the teacher's mailroom. The sign on the small copy machine behind Eileen, clearly reads "for emergency copies-only!" One decision by the Administration that was not welcomed this year by the teachers was to eliminate the full-time copier position due to budget restraints. Now, teachers must rely on a handful of secretaries to complete the copy duties and hope that the myriad of their teacher requests are met.

A few minutes later, Sunshine and Mike came into the mailroom. Mike was carrying his signature black and grey back pack over one shoulder, possibly a habit from his earlier days as an engineer. He placed his nylon lunch bag and thermos on the counter and went straight to his mailbox without stopping to converse. The priest must have been in a hurry this morning; the 7 a.m. mass was already over. While each member of the math department is Catholic, Sunshine and Mike are especially conscious of their Catholic faith and never miss the morning ritual of mass in the school chapel. Faith is a large part of the school's culture and the word 'family' is often used when describing the school's strengths.

With the student population continually decreasing, teachers are being asked to take on more and more duties. Along with their teaching assignments, each member of the math department tutors in the academic lab on rotating Mondays, as well as takes on roles of club moderators, coaches, or assistant coaches in the many activities and sports that are offered at the school. The many "hats" worn by the math department teachers is characteristic of a small private school.

The four teachers leave the mailroom together; each in their own thoughts. They head up to the "400s," the term commonly used to describe the location of the math classrooms. The school has two classroom buildings connected with a breezeway; the science department can be found in the 100s hallway; English and history are located upstairs in the 200s, while foreign language is in the 300s hallway; other classrooms, labs, and offices are located throughout these two buildings.

Lunchtime Meetings

Jane decided to have the department meeting during the math department's common lunch period. These 'department' meetings are typically held within one week of the principal's department chair meeting and true to character, Jane was within that timeframe. The five desks had been haphazardly removed from the six neat rows of desks and placed into somewhat of a half-circle at the front of the room. Jane occupied the first desk and began, what she would later describe as her, 'administrative duties.'

"So, I just have two things to go over...one of them is the learning lab sign-ups. We have 21 Mondays that we have to cover as a department." From there, Mike started a discussion as to the purpose of the learning labs, "Is the idea behind this to try to utilize the National Honor Society kids to tutor or to tutor kids ourselves?" Once Mike felt that his question had been somewhat answered, the next topic of business was approached by Jane, "Okay, then the other thing that we were going to talk about again is, the student portfolios." Jane proceeded cautiously:

So we have a couple ideas. One is getting folders, four colors-freshmen, sophomore, junior, senior-and then have some of the students put the labels on for us. They could receive community service hours for helping us and then I would also ask them to alphabetize them. The thought was that if we kept them all alphabetized from A to Z interspersed 9 through 12, we would make it easier to eliminate the seniors at the end of the year and we would have them all in order. We could also create a drop box for the student work and then we would each sign up for a week, for fifteen minutes of time, and file.

The explanation continued. “Every week we would be rotating, so we would be responsible every 5 weeks and we would do a little bit of the filing to keep on top of it.” The discussion continued about collecting different forms of student work, such as a test, a project, or the standardized test questions that the students practice in preparation for the SAT and ACT college tests.”

Mike started to question the idea behind the portfolios, “I want to ask a question to make sure I understand...in other words the thing that goes in the folder is typically...some kind of specialized ‘something or other’ that we do along with standardized testing. Do I understand that right?”

Jane said, “That’s what we’re thinking...that would be a great way to show student progression. If we start in the ninth grade, by the time the kids are seniors, we would be able to say, ‘Oh, look how much better they’re doing, or, look they made the same mistake this year””

“Can’t you get the reports that give the areas of weakness?” Sunshine asked.

“Yes, I suppose we can.” Jane said

Sunshine continued, “Yes, okay so if you get a report that says something like the area of weakness is, ‘special right triangles’ then you can go through the SAT booklet and pick out the problems on special right triangles.”

The look on a few of their faces indicated that the conversation was becoming complicated and raising their levels of stress by adding additional work onto their daily duties. With arms folded across her chest and eyes glancing downward for the majority of the meeting, it was clear that Grace was struggling with the conversation taking place. I found it necessary to step in and suggest a process of portfolios that I had incorporated

in my class the previous year, “when I wanted to put something in the kids folder, I handed back the graded work, discussed it with them and also handed back their folder. They put their work in it. I collected the folders and kept them in my room...it also allowed the kids to see their work, as well as their strengths and weaknesses.”

“You only had one class,” Eileen stated.

“What was that?” I had to ask. The window air conditioner hummed loudly and it was difficult to hear Eileen’s soft statement.

“You only had one class; we all have five classes.” Eileen and several others also expressed that they didn’t have enough room in their classrooms to keep five classes of folders. Just when I thought this may be a hopeless endeavor, Mike offered a different idea.

“How about a variation of this idea? Let me just throw something else out there. I hate this idea for the reason that we’re creating extra work so that we can put a ‘check’ in some box that we’ve done this. We’re not creating something we’re going to use, or if we’re going to use it, we’re going to use it for a limited number of students.”

“That’s not really true,” Eileen said.

Persistently, Mike continued, “But let me continue because I think I have an idea that we might be able to use for all our students.” Mike went on to explain that this ‘folder idea’ would help him when it came to preparing his students for their final exams. If the students kept all their tests in this folder, he could simply hand this back to them prior to exam time for the review. The others saw this as a possible solution for Mike but they weren’t all sure that it would work for their needs.

“But here’s the other problem,” Eileen began. “What do you do with the files at the end of the year when my kids move onto another teacher?” It was suggested that the files be stored in Sunshine’s office that was located in the 400s. As the team leader for the lower-level students, Sunshine had an office to keep the required and confidential paperwork and make necessary phone calls to parents. Mike replied, “You would have multiple folders.”

“But then you’re doing four times the work,” Eileen said.

“No, no...instead of it being in one folder, you have one for freshman year, sophomore year, and junior year,” replied Mike.

“Four folders instead of one,” Eileen and Mike continued back-and-forth.

“But the folder is immaterial.”

“But what I’m saying is you’re doing four times the work.”

“No, no, no,” countered Mike.

“Yes you are,” Eileen insisted.

“How? It’s just a different piece of cardboard that it’s in. It’s the same material on the inside whether it’s in one piece of cardboard or three, I don’t see the difference other than we paid for two more pieces of cardboard, and that’s kind of immaterial. That way when I get a senior (to teach), the student has a freshman year record, a sophomore year record, and a junior year record.”

In order to end the meeting on a positive note, it was necessary to suggest that the department ‘table’ the idea of portfolios for now. The bell was going to ring in a few minutes to indicate the end of their lunch. The conversation that took place clearly

indicated a need for further work in helping the teachers understand and design a workable solution for using student portfolios to enhance student learning.

The ‘lunchtime’ meetings continued throughout the year, to address the topics that were discussed at the department chair/principal meeting that was held the week prior. The math teachers felt that this was a nice way to meet their obligation of attending the meeting but also eliminating the need to do so after school when it seemed, that each day, they were all involved with after-school responsibilities. Most of this after school time was spent with the students one-on-one helping them, or giving make-up tests, or even allowing their students extra time to finish a test or quiz given that day. Mike shared, “In this department, I think the students are well-accommodated in terms of any extra help that they need.”

At the January department lunch-meeting, Jane discussed the Common Core State Standards and the major changes needed, “there is a bigger emphasis on student-centered learning and being able to reason, like explain where the answer comes from, not just what the answer is.” Jane followed this with information that was presented at the previous week’s math department meeting at the district level with the Assistant Superintendent as well as information about the Leadership Conference that would be convening in February to address strategic planning and the Catholic Standards initiative. The discussion was brief; most of the teachers sat listening to Jane’s explanation. Following the dissemination of important dates and information, the teachers had somewhat finished their lunch and were ready to discuss the next issue—textbooks. Jane began:

If we're going to try to request any textbooks, we need to do so now. My feeling, any more is, especially after hearing the Assistant Superintendent, the textbook is not supposed to be the, 'be all and end all.' It's supposed to be a tool on the side, and as long as we have enough of them, I'm happy working out of the ones that I have...the disadvantage is that they're old now, so they're definitely not on line.

Eileen and Sunshine added that their textbooks do have an on-line component. For the most part, the on-line books were not interactive, but offered the e-text, practice quizzes, and calculator guidance for students.

Mike added "Some of the textbooks are falling apart," another indication of the financial burdens the school was facing. "Yeah," said Jane, "I know what you're talking about. We were going to replace the geometry book last year, although really, the year before that should have been Algebra I and Algebra II." The burden of the expense and the weight of the textbooks for students were addressed and the topic closed with Jane asking the teachers for textbook requests to be submitted to her by March 1. The school was in the process of going to a one-to-one iPad program for the next school year, including on-line textbooks for any courses that required buying additional books. The new technology initiative was causing some apprehension and concern for the teachers, who for the most part, were comfortable in their teaching styles. Each teacher seemed to be at a different level when it came to integrating the technology into their courses.

Sunshine asked Jane for help with displaying her iPad screen through her projector, "I need whatever it is that you have that connects the iPad notes to the overhead."

"You mean a document camera?" interjected Grace.

“I think she means the program that connects it, the reflector thing?” asked Jane.

“Yes, that” replied Sunshine.

“Well, I’ve accidentally discovered, as an aside, you can put your iPad underneath the document camera to display it. But, it won’t let you wander around the room,” Jane said.

Sunshine explained:

You know the problem I’m having, and I don’t know if other people are, but with them (the students) having their iPads and laptops and all, I can’t see what they’re doing, and by the time I get back there, they have exited out of whatever it is...that’s what I like about your program (Jane), you can be in the back of the room and see what it is they’re doing.

“Yeah,” commented Grace.

“I bought it myself,” said Eileen.

“I bought it myself too,” said Jane.

“What is it? Is it a piece of hardware?” asked Mike.

“No, it’s software,” said Jane.

“You just download it...it’s like 15 bucks” added Eileen.

The conversation continued back and forth about the program and various problems of “mirroring” that might be encountered if numerous teachers were using it simultaneously. “I, technically, can display my stuff over here in Jane’s room if I want,” explained Eileen. Laughter erupted at the thought of playing tricks on a previous math teacher known to struggle with classroom management and teaching! The conversations were light hearted for a moment while everyone contributed their own recollections of

the teacher. The meeting ended with Jane asking the teachers for suggestions for a “wish list” the Development Office had requested as part of a new strategy for using donor money. Suggestions ranged from equipping all the rooms with the same technology to installing new lockers for the students and requesting new window blinds for several teachers. Just before the bell, the teachers stood and rearranged the desks back into the rows, gathered their belongings, and headed out, “I’ll e-mail you the minutes of the meeting everybody,” called Jane, as the door closed behind them.

Lunch in the 400s

According to the lunch schedule that is arranged by the school administration, the “hallways” usually have the same lunch period. On this particular day, four of the five math teachers gathered around the oval table that was placed near the East wall of their faculty lounge. Jane was the missing teacher that day; most likely, this was her “one planning period” day on the rotation schedule, “some days, I work through my lunch...I tend to sit at my desk and eat while I’m planning.”

Unfortunately, this room also shows signs of the aging school. The focal point of the room was the two large, mismatched sofas, separated by a glass coffee table that held a few outdated magazines scattered across the top. Beyond the sofas on the west wall, was a large screen TV that sat unplugged on the floor with the cable wire dangling from the ceiling above. Even though it appeared not to work, the large screen TV was clearly the only evidence of a more recent purchase or donation given to the school. The north wall was covered with windows and vertical blinds, both in dire need of attention from the maintenance crew. In front of the windows, two hunter-green arm chairs were arranged to slightly face each other with a small, white, wicker table in between, and on

the south wall were two older style wooden desks for teachers to work at; one had a telephone sitting atop a stack of local telephone books.

The conversation started with Sunshine, “Did anybody see Lincoln?” From there, they spoke of the reference in the movie to Euclid’s book, *The Elements*, and how Lincoln had read the book 12 or 13 times. Of course this agonizing feat probably would have been overlooked by anyone other than a math teacher, but the sheer magnitude of Lincoln’s accomplishment did not surpass Sunshine’s notice. They continued on exchanging back-and-forth about movies.

“We watched *The King’s Speech*” added Eileen.

“I like movies about kings and queens,” Sunshine added.

“Yes, and speaking of kings, I bet Prince Charles is getting anxious to be king,” replied Mike.

Two of the maintenance men had wondered in with their lunches in hand and found seats at the end of the oval table and all enjoyed a laugh or two as one of the maintenance man’s phone rang a total of five times during his short lunch and respite. After discussing the movies and sports, the four math teachers quietly cleaned up their place at the table and headed down the 400s hallway to finish their afternoon.

It was a couple of weeks later when the teachers who typically used the faculty lounge in the 400s decided to begin doing their own repairs. The two large outdated sofas had been removed and the wall hangings on the north wall had been taken down in preparation for a fresh coat of white paint. “Did you hear that even Goodwill rejected our sofas?” chuckled the Spanish teacher, and all joined in the laughter. On that particular

day, the lunch table was seated with the foreign language teacher, art teacher, and three of the math teachers: Jane, Eileen, and Sunshine.

Jane started the conversation in her humorous and sarcastic manner, “Opera was coming through my classroom walls again today; it usually makes me laugh,” but it was clear by the expression on Jane’s face that the sound of “opera” was not too pleasing today. The “opera” sound was in reference to the classroom next to hers that is used by the chorus and drama teacher. The Fine Arts department does a tremendous job of offering students music, art, and drama on a limited budget. Just recently, through the generous donation of one benefactor, a dance studio was built in one of the classrooms not being used. The band program, which consists of about 40 students, offers advanced courses, jazz ensemble, and concert band classes while working out of a portable classroom. The students have the opportunity to experience the arts through the school’s band, chorus, art, and drama courses. Each year, there are two concerts, a play production, and other numerous opportunities for students to showcase their talents. The lunch conversation veered off to the local theatre, the newest production, and the outrageous prices to see a performance—a sure sign we were now in the height of the “season,” commented one teacher.

The faculty lounge was painted one Saturday morning by three or four of the teachers in that building, including one of the math teachers. The couches were removed and replaced with an existing black leather one brought over from the faculty lounge in the other building. The art teacher, and several students, began painting an underwater sea mural on the east wall, and slowly, the teacher lounge in the 400s hallway took on a brand new look.

As the weeks past, the mural came closer and closer to being finished. The large screen-TV was angled in the corner, the oval table moved into the center as the focal point, and the older of the two desks were removed. The fresh coat of paint certainly brought a sense of newness to the lounge and the teachers were excited about taking the initiative to improve it. The dark stained crucifix hanging above the remaining wooden desk-a reminder of the school's mission and philosophy-was the only thing returned to the newly painted walls. The lunch table was mostly empty on Monday; the conversation focused on the upcoming conclave and excitement of a new pope being elected.

"I think Sean O'Malley has a good chance," said Sunshine. The other two teachers at the table raised an eyebrow, "Really? I would be surprised if an American was selected," replied one of them. Sunshine went on to defend the American Bishop saying that he knew six languages, was very holy, and had experience in handling problems surrounding the Catholic Church. Sunshine shared that she told her students the election of the Pope would be a historical time in their lives. For the remainder of their lunchtime, they recollected about where they were and what they were doing during significant, historical moments such as the first Space Shuttle accident and 9/11. Just before the bell, Sunshine wrapped the remainder of her chicken salad sandwich, finished her water, and headed for her classroom to start the afternoon classes. The others were close behind, discussing their remaining thoughts about a student on crutches.

The school policy when a student became injured and could not climb stairs to the second-floor classrooms was that teachers would either move their classes downstairs or the technology department would set up the teacher and student to Skype during the

class. If the technology worked, teachers usually chose this method of interaction. However, there were many challenges with this and sometimes, teachers had no choice but to move the class downstairs to an empty classroom. None of the math teachers particularly liked moving, but they understood the importance of face-to-face interaction with students and most, if not all, were always willing to abide by the school's policy without grumbling. For the teachers, it usually meant new seat assignments had to be done to keep order, computers, projectors, and screens were usually inconsistent with working, and precious time was wasted becoming accustomed to new surroundings, but, it has worked for over 50 years of students and if all goes well with fundraising, a new elevator will be built in the near future.

The Mailroom

Located in the East Building, the mailroom is the morning gathering room as teachers come and go, get their morning cup of hot coffee or tea, and exchange a laugh or sigh about a recent experience. Eileen stood at the copy machine that morning, copying a number of last-minute geometry worksheets, even though it was for one-copy only. Sunshine came in next, most likely just coming from the morning mass. She held a pink crumpled tissue in one hand and a collection of books and bag in the other.

“How are you feeling?” asked Eileen.

“Better, but I'm still not a 100 percent. You know, this is the third time this year that I've caught a cold,” exclaimed Sunshine. The math teachers were always aware when someone in their department was out sick. It was common for them to check in on their colleague's classes and make sure the substitute teacher had what they needed. Even though it wasn't spoken, you could sense their loyalty to one another. Grace

walked in, said “good morning,” went to her mailbox, and was thumbing through the papers when the mailroom door opened and the art teacher exclaimed loudly with a smile on his face, “Well, the gang’s all here!” Laughter erupted, and Eileen finished the comment with, “Now it is!”

It was the start of another day at the high school. A mixture of emotions amongst the teachers, some were in good spirits, some not so. There were a few “pink slips” in the mailboxes this particular morning. Luckily, it wasn’t a sign of dismissal, but a sign that a fellow teacher was out sick and it was your turn to sub. For the math teachers though, it was a good day-no pink slips in their mailboxes. Today, Eileen would start her class with the “5-minute check” that was her trademark; Mike would have a good story or two to tell for sure, most likely about the latest news item on the pope; Sunshine would quietly go about her duties of teaching even though she herself was probably not up to the task today; Grace was already ahead of the others in the hallway, eager to get to the students waiting for help, and today, because of her first period planning, Jane would linger in the mailroom looking for a good conversation. All in all, it looked like a good day in the math department.

Chapter 5: The Findings

The purpose of this ethnographic study was to understand teacher leadership and professional learning in a secondary mathematics department. Chapter 1 spoke to the importance of teacher learning and leadership. Fullan (2007, p. 35) sums up this importance by stating, “Student learning depends on every teacher learning all the time.” Professional learning is needed to affect teachers’ practices, especially with the emphasis on testing and focus on the Common Core State Standards in Florida. Teachers learn best by “studying, doing, and reflecting; by collaborating with other teachers” (Darling-Hammond, 1998, p. 7). The rationale for this study focused on three ideas: educational reform efforts and the concern for low student performance in mathematics; the need for effective professional learning for teachers that will impact student learning; and, the move to leadership in schools that is more reflective of a distributed leadership style, where the culture of the school indicates teacher leadership. The theoretical frameworks that guided this study were Adult Learning Theory, Social Learning Theory, and Distributed Leadership Theory.

Chapter 2 presented the literature review for teacher leadership, the high school organization, math departments, math reform, and professional learning. Chapter 3 discussed the methodology of this study and the aspects of ethnographic research that set it apart from other forms of research. Finally, Chapter 4 told the story of the math department, giving glimpses into their daily activities, discussions, and behaviors in order

to understand the culture of learning and leadership that existed in the department. Chapter 5 presents a brief timeline from accessing the gatekeeper to the final set of interviews. Findings to the four research questions are presented. Specifically, this study addressed these research questions: What does teacher leadership look like in a selected secondary mathematics department? What are the formal and informal roles of leadership within this secondary mathematics department? How do teacher leaders in the department create opportunities for professional learning? How do teachers experience professional learning in this selected secondary mathematics department?

Ethnography is interpreting the shared beliefs, language, behaviors, and values of a “culture-sharing group” (Creswell, 2007, p. 68). Therefore, understanding how teachers learn professionally and how leadership emerges amongst teachers in a mathematics department can best be described using an ethnographic approach. The data were collected through frequent, long-term observations, a series of in-depth interviews and document analysis, allowing the researcher to become “immersed” in the culture.

To gain access to the institution, ethnography typically employs entry through a “gatekeeper,” an individual who has close ties with the cultural group being studied (Creswell, 2007, p. 71). As the department chair, Jane was the ‘gatekeeper’ who received the initial communication in late May of 2012 regarding the research study. The president of the selected school and the school superintendent were contacted in person and their permission to complete the study was received in June of 2012. The five teachers received a letter explaining the research and asking permission for their participation in this study (Appendix B). Once Institutional Review Board approval was given by the research institution in early September, the math department teachers were

contacted through e-mail to set up the first round of interviews. The data collection took place from September 2012 to April 2013. The interview process was divided into three stages: beginning, middle, and end of the study. The three semi-structured interviews allowed for a better understanding of the teacher's learning and leadership opportunities throughout the 7-month time period. The first round of interviews took place in early October; the second round of interviews took place in December before the teachers left for Christmas vacation; and the last round of interviews took place in mid-March. The interviews were conducted during each teacher's planning period or after school. The interviews were recorded and transcribed. Informal, spontaneous interviews occurred with the teachers during lunch, in the mailroom, and after school during some of the professional development times. One of the defining characteristics of ethnographic interviewing is the building of relationships between the researcher and the participants. Heyl (2001) states, "the significant time invested in developing, through repeated contacts and multiple interviews over time, a genuine relationship involving mutual respect...evolves" (p. 379). Knowing and having a relationship with the math department teachers prior to the start of this study helped to ease the interview process.

Frequent observations of the math teachers took place during their morning routine of checking their mailboxes, picking up their copy requests, and getting their coffee or tea. This typically took place from 7:15 a.m. to 7:45 a.m. The teachers were also observed during their lunch break in the faculty lounge in the 400s hallway and at their math department meetings that were held in Jane's classroom. The math teachers participated in the school's professional development programs that were scheduled from 12:45 p.m. to 2: 15 p.m.; observations of the teachers, throughout the year, during these

programs were also completed. To become immersed in the culture requires the researcher to commit enough time to the community under study so that the researcher is able to “internalize the basic beliefs, fears, hopes, and expectations of its people” (Fraenkel et al., 2012, p. 512). This, in turn, allowed a holistic picture of the math department to emerge.

Findings: Research Question 1

What does teacher leadership look like in a selected secondary mathematics department? Teacher leadership took on formal and informal meanings for the teachers. For one teacher, the role of department chair was a “formal leadership position.” Jane said that it would be difficult “for others to be leaders” because of the size of their math department. “If we had different grade levels, it would be easier; there’s a person in charge of all the teachers in that grade, like at my daughter’s school.” She laughed when she said, “We could have an Algebra II department because, technically, that’s the only area where there are three of us teaching.” Department chairs were required to attend a monthly meeting with the principal and then meet with their respective departments to relay needed information.

Informally, teacher leadership was ‘sharing’ between colleagues, which became very evident in their everyday meetings and conversations. One teacher even said that to her teacher leadership meant, “When a teacher has a good teaching idea, to share it with other people in their department.” Another teacher commented, “I would say we talk, on average, at least once a day.” If a teacher had a math-related, student-related, or classroom management related question, they first went to someone in their department for help. One teacher shared, “I usually find if it’s a teaching problem, per se, it’s more

helpful to go to somebody in the department.” This was confirmed by Grace as well, “I would definitely go to a peer that I tend to bounce things off of.” Conversations between colleagues occurred before school in the mailroom, in the doorway of their classrooms, and during lunch, as well as after school. Grace commented, “The department head came to my room this morning and told me what worked in her Algebra II class the previous day.” When asked about talking with colleagues, Jane commented, “Whenever I can! If we see each other in the hallway, in between classes, we stop and chat.” Another teacher added, “Multiple times a day. Jane and I spoke this morning regarding some things going on in my classroom and then again at lunch, and I will probably see her after school to review our exams.”

A morning conversation, between two of the teachers, included the exchange of teaching ideas about graphing absolute value functions, along with the teacher’s arrangement of the classroom desks into groups of four. Additionally, a frequent technique used to factor quadratic expressions by one teacher led to a department-wide learning experience and continues to be used each year. Mike commonly referred to it as the “trash can method.” Jane said, “Prior to that, a student taught me a method called ‘tic-tac-toe’ which I thought was the easiest method until I learned the trash can method; now I share that!” Grace was so excited about the trash can method that she asked me during the interview, “So, do you want to see an example of it?” and proceeded to solve a problem on the paper in front of her.

With the technology initiative of the school this past year, students were permitted to bring their own personal devices to use in the classroom. Also, each teacher was given an iPad before Christmas break to begin learning how to incorporate the technology into

some of their lessons. Teacher leadership was evident, once again, as teachers shared ideas and helped one another. During one of the department meetings, Jane explained, “The *Reflection Program* lets you display your iPad screen through your computer. Once you get the program yourself, ask me, and I’ll come show you how to use it.” Two of the teachers that teach a common course share documents, such as lesson plans, exam reviews, and notes, through *Google Docs*. Several of the teachers use *GeoGebra*, an interactive program, for geometry, algebra, statistics, and calculus. After a demonstration of the *GeoGebra* program was given to the department last year, Jane took the initiative to explore it further and find ways of incorporating it into her curriculum. One of the projects that she shared with the other two algebra teachers emphasized the concepts of graphing different equations. Sunshine remarked, “I now use the *GeoGebra* program in my IB class for graphs and to reinforce certain concepts.” A few of the student’s graphing projects are framed and proudly displayed in the 400s hallway.

Another initiative of one teacher helped other teachers in the department in terms of using Khan Academy videos in their curriculum. Mike spent numerous hours over the summer and during the school year incorporating math videos into his lessons and as homework assignments. After discussing this with some of his colleagues, together they were able to solve some of the technical problems he faced with the program. Mike said, “I learned from one of the other math teachers how to get the students signed up...but we still struggle with knowing how to grade the students using the program. The difficulty is in the grading-there are three places from which you can take the grade and we haven’t figured out how to make those three consistent.” However, the collaborative work on the

teachers' parts eventually paid off as, together, they were able to "crack the code," as one teacher said, on the grading system.

Teacher leadership was experienced both inside and outside the math department and did not always mean leadership was related to mathematics. One teacher defined teacher leadership as, "volunteering and stepping out and stepping up to the challenge." Two of the math teachers served as committee chairs in preparation for the school's 5-year self-evaluation required by Southern Association of Colleges and Schools (SACS) for re-accreditation purposes. In addition, all of the math teachers took on additional roles of leadership as class and club moderators. These included roles as assistant drama coach, freshmen class moderator, assistant junior class moderator, Eucharistic ministers and lector's moderator, Faith Club moderator, Spirit Club moderator, and assistant cross-country coach.

Mike felt the math department set a "tremendous example" of Catholic leadership when two or three of the teachers attend the morning mass regularly, "The mass is at 7 a.m., so not a lot of students see us going to mass, but I think they know it. It's more of an *example* of leadership, but it's clearly there." Grace and a number of the math teachers shared that part of their daily routine is prayer in the classroom. Catholic leadership is an important part of the mission and philosophy of the school. Tradition is visible throughout the school in their academic achievements, athletic accomplishments, school liturgies, student activities and social events, through community service hours and projects, and through the physical elements of the campus. Perhaps, more importantly, tradition is felt through some of the things that are not as visible: the culture of the Catholic, Christian community that the school represents; the belief that it is the

school's responsibility to teach "the fundamental values of loyalty, responsibility, mutual respect, common courtesy, integrity, honesty, and common sense;" and, the belief that teachers and staff play a vital role in preparing students in the "ethical teachings, continuity, and the traditions of the Catholic Church" as stated in the School's Philosophy and Mission Statement. Together, these documents represent a sense of Catholic-identity for teachers and, as one teacher commented, the leadership example of the math teachers "says a tremendous amount about where these people are in terms of values; it sets a wonderful example for students."

Teacher leadership, defined for the purpose of this study, is leadership for the purpose of improving the teaching and learning of colleagues. Teacher leadership, therefore, occurred on many informal levels through daily talk and sharing among colleagues, through the additional roles of leadership in and about the department, and through the Catholic leadership examples set by the teachers that reinforced the mission and philosophy of the school.

Findings: Research Question 2

What are the formal and informal roles of leadership within this secondary mathematics department? The formal role of leadership, in the department, is the department chair position which is held by Jane. Currently, Jane has held this position for the last 8 years, but swears she "never checked it off" on the yearly form that is distributed, entitled Academic Preferences; "this just sort of fell in my lap," she contends. The formal position, Jane feels, is mainly for completing administrative duties, "I don't feel in charge...I feel like I'm responsible for dotting my 'I's' and crossing my 'T's' and making sure the paperwork gets turned in." The 'administrative duties' were confirmed

in observations of the monthly department meetings and the minutes that were provided. During one observation, Jane started the meeting with, “So, I just have two things to go over.” A reminder about signing up for the after-school learning labs and student portfolios were discussed. Other topics included upcoming dates of importance, technology in the classroom, ideas needed for improvement projects in the department, major changes that the Common Core State Standards will bring in math, and dividing up the graphing calculators between the teachers. It was observed and noted that the formal role of math department chair was to disseminate information from the principal’s monthly meeting with all department chairs, as well as from the quarterly meetings that Jane attended at the District level.

The opportunity for Jane-as a leader in a formal role-to influence the learning of her colleagues appeared to happen in the random meetings and conversations over lunch, after school, or before school. It was only recently, at the February department meeting, that a teacher asked Jane to provide training, “Could we schedule a future meeting Jane, with you demonstrating the use of the iPad?” Jane was asked, several years ago, by the school’s administration to be a member of the *Science, Math and Reading with Technology* (S.M.A.R.T.) program, a grant program in connection with the No Child Left Behind Act, for teachers in public and private schools. She explained, “The iPad is from the school, but everything else that I have-the MAC book, the scanner, digital camera, and iPod-are from the public schools’ grant.” With these tools and training, Jane explained she was able to incorporate more technology into her lessons than most of the other teachers in the department. But still, Jane felt that her strength was in the classroom with her students and not as the leader of the department, “Sometimes when I’m in front

of them (the teachers) in the meeting, I feel like they know more than me... I never wanted to be a leader.” Even so, comments from teachers included, “I think our department chair is a very caring person, not only about the quality of instruction for students, but she is very caring about each of us, as individuals.” In addition, “she (Jane) tries to be very fair and I don’t find her to be demanding at all... I feel fortunate that she is our department chair.” Still another teacher said, “Our leadership is strong - I think we’re very connected. There’s a comfort level.” Another teacher commented:

I feel comfortable going to anybody in my department; I think we have that ‘open door’ with every one of us... we normally get to have lunch together, which is a nice thing... there’s such a family sense here, and somebody is always willing and able to help.

In the department, there exists a culture focused on student learning. The school policy, as stated in the Faculty Handbook, requires teachers to be available until 3 p.m. in their classrooms for additional help. Often, the math teachers are in their classrooms well beyond the 3 p.m. requirement. Mike commented, “In this department, the students, I think, are well-accommodated in terms of any extra help that they need.” There is a genuine concern for the student and their learning, as witnessed in another teacher’s comment, “One thing I like to do is ask the students, ‘how do you learn best?’ and I don’t get offended when kids say they would rather do it ‘this way’... it’s about them learning.” When the students were not successful with a project that required them to use the *GeoGebra* program, Jane was concerned about their understanding, “I gave it back to them so that they could have a chance to fix it. They had things wrong on it,” She explained that her goal was, simply, for them “to learn it.”

The mission statement of the school addresses the individualized attention and the dedicated and supportive faculty, “We dedicate ourselves to discover each student’s unique talents and to prepare each student intellectually to make mature decisions about his or her future... We pledge to provide a faculty who understands the diverse needs of each student and who works with each student in a caring and supportive environment.” This was evident as the teachers explained, during their interviews, some of the interactions with students. One math teacher explained her approach to student behavior:

And particularly, if there’s a sudden change in behavior, I try to find out why... I’ll touch base with the guidance counselor to make sure there isn’t some issue going on at home, and I do ask students if there is something I could do that would help them to understand the material better.

Another comment about struggling students showed the teacher’s concern for how to best help the child, “I try to come to the best resolution... do they need extra help? Do they need tutoring? Do they need to sit in front of the room? But, I always try to put a strategy in place to address the issue.” Concern for student learning was also evident in the amount of pressure and stress that teachers felt. During one conversation, Eileen explained how she would enjoy showing her students the relationship between the Native American culture and geometry, “I’ve always wanted to work that in somehow, but I just don’t feel there’s enough time.” She felt overwhelmed with her responsibility to finish the curriculum. When Mike described his work using test data and the Excel spreadsheet, he said, “it’s the right thing to do to get a glimpse of the student’s learning, but there’s so many right things to do that there isn’t enough time to do all the right things and therein lies the problem.” Another teacher wanted to help her students learn

more about the *GeoGebra* program, knowing that the program itself had numerous tutorials and help available for teachers, but wondered, “Where do I get the time?” Still, another teacher was worried about finishing the curriculum after the school was closed for several weather related days during hurricane season. The dedication and concern to student learning was evident in the teachers’ comments and behavior, a reflection of the leadership and culture of the department.

Teachers in the department were also concerned about developing their own learning, “I think keeping that willingness and openness to learn is important for a teacher. I think that’s what works with teaching-it’s not an absolute here.” And the teachers were excited when the students remembered topics from previous years, “I love it when I hear, ‘Oh, I remember, I remember.’” Mike shared the contents of an e-mail message he received from a student in college, “I am so happy I was in your calculus class last year because I have a Chinese teacher who goes way too fast, but it’s easy to understand and I’m able to keep up...thank you.” On the other hand, teachers also get frustrated with themselves when they feel that their students aren’t learning, “This year especially I feel like I’m a failure at it. I don’t have enough kids going, ‘this is fun’...I don’t see the spark!”

The formal role in the department is the department chair position. It has been noted, through the interviews, observations, and document analysis, that this position primarily dealt with administrative duties and dissemination of information rather than instructional leadership. However, teacher comments and observations show a culture of trust that has developed in the department- teachers feel comfortable with one another.

The informal roles of leadership in the department included several. One math teacher organized and ran the three blood-drives the school held that year. Another math teacher made the arrangements for him and several students to visit and tour a Catholic university in the area and organized participation in the Right to Life demonstration at the court house that year. In addition, all the math teachers held club moderator positions or coached an athletic sport. These leadership positions included: Freshmen Class Moderator; Junior Class Moderator; Assistant Cross-Country Coach; Assistant Drama Coach; Faith Club Moderator; Eucharistic Minister and Lector Moderator; and Spirit Club Moderator. The small size of the school and the limited financial resources result in teachers taking on additional roles. The math teachers consistently helped in this area and lived up to the mission of the school that states, “we will provide a well-rounded curriculum and program” that offers “religious, extracurricular, athletic, and community service programs in order to form individuals who accept leadership, are academically inquisitive, spiritually alert, and physically sound.”

Teachers were also leaders for one another. When teachers had questions about math topics, student concerns, or discipline issues; four out of five teachers said they go to their colleagues first. The department chair mentioned how one teacher in particular provided support to others, sometimes in other areas besides academics:

She has the biggest shoulders for listening to something and then getting things done. I just feel like she has it all together, even when she is stressed out beyond belief and smoke is coming out of her ears. She’s organized; she knows her material; she’s very confident. She may give the slight roll of the eyes with ‘what do you want know?’ but she doesn’t mean it (laughing) and if you’re not looking

for it, you don't see it because she really, truly cares about how people perceive her and what people want....she's the web that holds us all together.

In addition, during the Christmas door decorating contest, some teachers within the department took active leadership roles in student supervision, "It wasn't necessarily my classroom, or my homeroom, but never the less, there were students present, so we were patrolling the hall making sure they were doing what they should be doing and then making sure the kids got back in the class." Teachers felt that anyone in the department had the opportunity to be a leader, if they wanted. As one teacher said, leadership is about "volunteering...stepping out and stepping up to the challenge."

Findings: Research Question 3

How do teacher leaders in the department create opportunities for professional learning? Through personal interviews and observations, teacher leaders in the department, had opportunities to impact their colleague's professional learning during the formally scheduled department meetings and school-wide in-service programs. During the October in-service meeting, Grace commented that she really enjoyed when the different department members presented teaching ideas; "I thought it was awesome when each department presented helpful hints, tips, and strategies that have worked successfully in their classroom." During another meeting, Mike and one of the Foreign Language teachers discussed using data in their classrooms to improve student learning. Mike was able to add additional help in the area of statistics and the Excel program:

In the AP statistics course that I'm teaching, there is an add-on program that ties into Microsoft Excel that lets you do a histogram immediately with anything you

have. In fact it lets you do all kinds of statistical graphs for whatever kind of assignment that you get.

Mike and the other teacher presented an example of using data that easily converted to graphs for feedback to teachers on their students' learning. With this knowledge, Mike explained, the teacher is able to re-teach concepts. The template was then shared with the other teachers as an attachment through e-mail. Teachers were asked by the Administration to experiment with the template and use it in their classrooms to inform their instruction.

Using technology also provided opportunities for teacher leadership. During an interview, Jane explained that this year, the teachers in the SMART program were responsible for creating three iBooks. Her first iBook focused on topics in Trigonometry. Since this topic is covered in calculus, geometry, and the IB program, she was able to share the book with the other teachers. The iBook used interactive examples and quizzes to help students understand the material. The enhancement of technology to the curriculum continued to offer the teachers of the department an opportunity for leadership as they discovered new apps, programs, and resources. On one example, Jane was one of three technology presenters responsible for teacher training using the iPad. She used the *Socrative* app to show teachers how they could incorporate quick assessments into their daily routines using the mobile device.

Eileen also had extensive training with concepts surrounding Professional Learning Communities (PLC's). Over the last 3 years, she estimated that she attended between 20 to 25 formal workshops held throughout the county. At the school-wide in-service day in October, Eileen explained the concept behind the PLC's, giving an

example of how PLC's can address different areas of concern in the classroom. One problem noted by teachers in the past, she explained, was that students did not take the time to accurately read instructions before tests and quizzes. Classes were often disrupted then by students asking unnecessary questions. Teachers involved in the PLC implemented a policy that they would begin test and quizzes with a 5-minute time period of reading instructions and allowing students to ask questions for clarification. During one of our interviews, she shared another strategy about re-wording a question so that the students would have to think more deeply and illustrate their answers. This idea could be used "across curriculums," she said.

At the department level, teacher leaders also had the opportunity to present ideas at the monthly department meetings. Last year, Mike submitted a proposal for adding an AP Statistics course to the math curriculum. It was an effort to "better serve our students in college and to encourage students to reach their highest potential." From that proposal, Mike went to the AP summer institute, prepared the course syllabus, and was able to add it to this year's course selections. Eileen also offered that teachers have the opportunity to share ideas during the meetings, and, as she stated, "I would also have no problem sending an e-mail or just telling people at lunch or in the morning if I thought I had something important to share."

Through the interviews, it became very apparent that the teachers wanted opportunities for professional learning. One teacher talked about the need to focus more on application problems to help students prepare for the ACT and SAT college entrance tests, "I think it would be a good idea for us to have some kind of unified effort to help kids with test questions. And we've talked about doing that in the past; it's a matter of

implementing it!” Another teacher would like to learn more about using the graphing calculator in the classroom. She noted, “Not to take away from understanding the concepts”, but to be able to say to students, “here’s another way of doing it.” Other teachers spoke about wanting more professional learning on technology. With the school implementing personal devices in the classrooms, teachers were trying to stay on top of the advances as much as possible; “I think we need a technical guru that can come and show us. And, we probably need to see them in action...because, where I am right now, I can’t afford to give the time to anything that might diverge from my responsibilities right now.” Other areas of technology training that they wanted included using the iPad and the Reflection program, which would allow them to show the iPad screen through their projector onto the whiteboard or screen. At the end of one department meeting, a teacher asked Jane, “Could you show us what you do with your technology, like this, during one of our common lunches?” With all teachers in agreement, it was evident that teachers wanted to learn.

Teacher leaders created opportunities for professional learning during the formal school-wide in-service programs that addressed topics on using data in the classrooms, teaching strategies, PLCs, and using technology. Teacher leaders also created opportunities for professional learning at the department level by taking initiatives on adding courses and through professional dialogue-sharing ideas and resources. Teachers in the math department gave many examples of professional learning that they were interested in; future opportunities for leadership and learning to connect.

Findings: Research Question 4

How do teachers experience professional learning in this selected secondary mathematics department? Sunshine shared that one of her best learning experiences was when she worked with Dr. C. regarding student learning differences, and while this experience happened over 15 years ago, the knowledge that she gained from it is evident in her responses:

I had no clue about learning issues or students learning differently or anything like that; she really took a lot of time with me to teach me. She, I would say, opened my eyes a lot. All students aren't the same and trying different techniques with different students can help them to be very successful...and I think that probably the main thing I've learned is that you always have to be open to change, that teaching is not static; everyday is different.

From this experience, Sunshine asked students, "How do you learn best?" She said, "It's about them learning...I'm not a mind reader." Her approach to classroom management issues reflected this as well:

I try to take the approach of dealing with the student first and asking them if they are aware of what the issue is and how would they like to take care of it; and sometimes that works...I always say there's no excuse for bad behavior, but some students really face some difficult issues.

Another example of professional learning took place when a local university professor came to the school and trained the math teachers using the *GeoGebra* interactive math program. From that initial training over a year ago, Jane worked with

the program until she felt confident using it in class, “I was excited about it; I played around with it until I learned how to use it better.” After teaching herself, she made rubrics and required her students to complete their math projects using the program. It took time for students to be successful; she explained, “I gave them a chance to fix it because they had things wrong on it. I want them to learn it” and she wished that “everybody” in the department would use “a program as nice as *GeoGebra*” for graphing.

Sometimes, the professional learning was not related to their specific subject matter, but did provide the teacher with valuable knowledge that could be used when working with students. Sunshine described her learning as it impacted her teaching methods when she dealt with the struggling math students:

I have been working with Dr. T recently, our school psychologist, and we’ve come across a number of students with significant educational and social problems. We are trying to work more closely with the parents to identify what issues they are dealing with so that I can be more effective in the classroom dealing with them.

The math teachers experienced professional learning through talking and sharing ideas with one another. As one teacher described it, professional talk with colleagues occurred “on a daily basis, before school-certainly during lunch-and occasionally after school.” Each teacher had a particular strength in one or more math topics and was usually willing to answer a question or explain a problem. Mike said, “Occasionally someone will come and ask me a calculus problem, or someone might come for calculator advice.” Jane shared, “Any techniques about algebra II that I find, I just immediately go to Grace,” and two other teachers said they “run ideas by each other” on

a regular basis. Sometimes the professional learning even occurred at school athletic events. Eileen shared that one night at the volleyball game she and another teacher, from the opposing side, were discussing the use of technology in the classroom. Eileen learned that the teacher's classroom management, when using technology, included the students "e-mailing their notes to her" randomly. Eileen said she shared this idea with the teachers in her own math department since the school was in its first year of students bringing their own devices and there was always a concern if students were on task. Lunchtime conversations provided teachers another opportunity to learn. Even though the conversations were light, fun, and distracting from the normal routine, teachers did occasionally talk 'shop:'

At lunch today, the calculus teacher was asking me a computer question. He had a program that he was using and he thought my knowledge with the MAC computer might be able to help him. The program he was trying to use had just been updated to a PC from a MAC.

Other lunch conversations included teachers sharing strategies:

At lunch, people share their frustrations like, 'Oh my class is having so much trouble with factoring' and then somebody else says, 'Oh, I tried this and found that this worked really well.' So I always try to use other people's ideas.

Sometimes, learning occurred through conversations with people outside the math department. Eileen explained that there were other people who were knowledgeable about her course- financial algebra- including the football coach, who had an insurance business, and her husband who also had a financial background. Eileen wasn't afraid to ask for their advice, "it depends on what the topic is...I have a number of friends who are

also accountants,” she said. When Mike is stumped with a math problem, which isn’t often, he said he goes to his son, “He has a Ph.D. in mechanical engineering.” Teachers also learned informally from their students-mostly about technology:

One of my students helped me figure out what that one crazy button was used for on the calculator. I love when I learn from the kids...and this particular kid was barely hanging on academically, so for him to have figured that out was awesome.

Another teacher commented:

There was something on the calculator that neither Mike nor I could figure out for the longest time and it had us so frustrated. One day a girl looked it up on her laptop and said, ‘Oh, I think I know’ and she showed me...and it worked!

Teachers also learned by watching each other. “I think when you watch other people do things, you learn something all the time,” Eileen said. Mike also agreed saying:

Sitting in another class is probably the best way to learn from one another, and you probably learn more than the subject matter kind of stuff. You’re looking at how that person is handling an unruly student, or how is that person handling the good student...and all of the stuff that goes with it.

Additionally, teachers experienced professional learning through formal workshops and school in-service programs. Four out of the five teachers had opportunities for formal learning through workshops held off-campus and all five teachers attended the school in-service opportunities held on-campus. All expressed, that in some way, their teaching practices were changed because of these experiences. Mike stated:

When I went to the AP Institute for AP Statistics this summer in Texas, I was kind of amazed when I listened to the other teachers-it was an Institute for new AP teachers. We were hearing from an experienced teacher for four solid days how he was teaching his AP material, and he was a very good teacher...I learned a lot.

At the first department chair meeting of the school year, the idea of the “flipped classroom” was presented and discussed amongst all the department chairs. This educational practice involves teachers “flipping” the instructional time in the classroom with homework time at home. When Mike heard about this practice, he felt that this might be a way to help his students understand the calculus and statistics material better. He expressed, “If I send them home to do homework problems and they don’t know what they’re doing, it doesn’t really accomplish anything other than take some of their time that could be better spent doing something else.” In terms of his professional learning, the videos changed his teaching practice, “From a teaching methodology standpoint, yes. I watched a lot of Khan Academy, but not for the purpose of learning myself. I watched for the purpose of seeing if it would be appropriate with the lesson I was trying to teach, so it changed the way I delivered my instruction.” Mike felt that having the students learn the lesson prior to the class was “helpful” and it provided another source of information for students who struggled.

As a member of the SMART program, Jane attended six formal workshops throughout the year, as well as completed the technology projects assigned. She was very excited about creating the iBook and she felt that her own learning had “increased significantly” in the area of technology because of this opportunity. The biggest

drawback, she explained, was the lack of time in being able to fully explain the implementation of technology into her lessons, and the iBook project with the other teachers in her department.

Learning through outside workshops gave the math teachers ideas and strategies that they brought back into their classrooms. The school began working with Professional Learning Communities (PLCs) several years ago, but was not able to maintain the momentum for various reasons. However, the school administration renewed the focus and sent small groups of teachers to workshops this past year. As one of the original teachers trained on the PLC concept, Eileen said, “Every time I go to one of those workshops, I come back with at least one thing that is just a different way of doing something or a different way of thinking about something.” After the most recent workshop that she attended, Eileen said she started using a new questioning technique in her class:

You flip the question around. You actually say to them the answer is ‘this’, now you come up with the question...I was doing the congruence of triangles with my regular geometry classes, so their opening question was, ‘the answer to the question is side-angle-side. You draw the picture.’

Aside from giving Eileen a different instructional strategy, she explained that another benefit was that the students were engaged and presented their work on the board, “We try to figure out if they’re right or wrong? And then they can compare it to their own answer.” Eileen said that because of what she learned at the workshops, she’s “way more comfortable” with students working in groups or with partners. As a result,

Eileen said, “The PLC workshops...have definitely changed things that I do or don’t do in class.” Grace also had the opportunity to attend a workshop and said:

It was really thought-provoking, very engaging. It really made you step outside of the box in getting you to think on a higher level so you can draw that out of your students-not just to get the concept-but get the bigger picture...and for me, that made me want to come back into my classroom and think of more effective, not just efficient, but effective ways for achievement.

Grace felt that, even though it was a lot of work preparing for her absence from class, she learned something from the experience. She said, “I’m a firm believer there’s always room for improvement...and not going to these (workshops) means I would never know there’s another, better way.” Grace said she was looking forward to the next workshop that was coming up in a few weeks.

Professional learning also occurred through individual reading and research. The department chair received monthly academic math journals which she shared with each teacher. Teachers said that they used ideas out of the journals in their classes. Jim expressed that he learns his subject-matter best by reading, “I’ve read the statistics book once all the way through before I taught it, and now I’m reading the book a second time just enough to teach it.” Another teacher also shared that reading other textbooks and looking at examples on the same topic was helpful for her professional learning.

Several teachers expressed an interest in Whole Brain Learning, a topic presented at one of the school’s in-service programs in the fall. This instructional technique uses the latest brain research to create more engaged learning environments:

It's just a dynamic way of engaging students, it makes it fun, and for me, it's really stepping out of my comfort zone, but it works! Research has shown it works...and it's okay to step out of the comfort zone because I think that's when you become a better teacher.

Another teacher shared that she was at the front of the room using hand signals and choral responses to get the kids engaged. About 15 minutes later, a student unsuspectingly responded to her using the same choral response-she knew she had made an impact. Jane said, "I was so excited, I gave him a homework pass." For Grace, understanding more about the research on Whole Brain Learning became a goal, "I'm going to try during the upcoming break to do some research and visit the websites." Grace agreed to present her research and learning to the faculty at a future school-wide in-service program.

Teachers in the math department experienced professional learning through conversations with colleagues and other professionals. Students also became a source of professional learning for teachers, usually in the area of technology. Finally, teachers experienced professional learning more formally through individual reading and research, school-wide in-service programs, and through outside workshops and programs.

Chapter 6: Discussion, Recommendations, Conclusions

Discussion

The purpose of this ethnographic qualitative study was to understand teacher leadership and professional learning in a secondary mathematics department. As math educators face challenges of improving test scores, incorporating technology, and specifically, in Florida, addressing the Common Core State Standards (CCSS), it is imperative that teachers have effective professional learning opportunities that will change classroom practices. The problem that we face is professional development has had a reputation of being “one-shot” workshops that are ineffective and unrelated to content and pedagogy (Cohen & Ball, 1999, p. 4). Fullan (2007) wrote that the time has come to deprivatize education; it means that all teachers need to take risks, share ideas, and open classroom doors. Professional learning is engrained in the everyday activities and random meetings between colleagues. It is the discussion that takes place about student learning, subject-area questions, and the day-to-day challenges teachers face. In addition, educational leadership is changing from a hierarchical approach to a practice of distributed leadership. This distribution of leadership occurs when the leadership function “is stretched over the work of a number of individuals and the leadership task is accomplished through the interaction of multiple leaders” (Spillane et al., 2001). It therefore considers, not only the formal roles of leadership that exist within an

educational setting or subject department, but the informal roles of leadership that may have a “greater influence over leadership practice,” namely, teachers (Harris, 2005, p. 11).

The significance for studying and trying to understand the culture of learning and leading in a department setting is to determine opportunities to affect teachers’ professional knowledge and how teacher leadership can impact these opportunities. School leaders must understand the importance of the internal opportunities that are within their reach to affect teacher learning. Drago-Severson (2007) suggests, “We need greater knowledge about practices that support teacher learning and growth by focusing on how teachers make sense of their experiences” (p. 71). Specifically, this study addressed the following research questions: What does teacher leadership look like in a selected secondary mathematics department? What are the formal and informal roles of leadership within this secondary mathematics department? How do teacher leaders in the department create opportunities for professional learning? How do teachers experience professional learning in this selected secondary mathematics department?

Qualitative research relies on a “holistic description” of a particular situation, phenomenon, or activity (Fraenkel et al., 2012, p. 426). In this ethnographic study, five teachers in a specific high school math department formed the subgroup under study. A combination of observations, in-depth interviews, and document analysis was used to collect data. A defining attribute of qualitative data uses words and rich description, rather than numbers. “Words, especially organized into incidents or stories, have a concrete, vivid, meaningful flavor, that often proves more convincing to a reader...than pages of summarized numbers” (Miles & Huberman, 1994, p. 1). To achieve this level of

understanding, qualitative research employs several unique procedures that set it apart from quantitative research. Some of the characteristics used in this study included: the research was done in the natural setting; data collection methods were in-depth interviewing, observations, and document analysis; the research was “emergent” rather than hypothesized; the research was interpretive, seen through the researchers’ personal lens; and the process of data analysis focused on reoccurring themes using “inductive and deductive processes” (Creswell, 2003, p. 183). Chapter 4 presented the narrative of the teachers, in their natural setting, depicting their way of life in the math department. In an attempt to understand the culture of learning and leadership within the department, as well as present a holistic picture of their daily routines, behavior, and customs, thick description was used as teachers navigated through the mailroom, ate lunch in the teacher’s lounge, and gathered for department meetings and school-wide in-service programs. Chapter 5 presented the findings to each research question, along with a description of the data collection process.

The researcher validated the accuracy of the findings using triangulation with interview statements, document analysis, and observations. Triangulation establishes validity by comparing the findings through several data collection methods, such as participant observations, interviews, and document analysis. By locating similarities, triangulation supports and gives credibility and “accuracy of the researcher’s interpretations” (Fraenkel et al., 2012, p. 517). Member-checking was used to confirm the transcriptions verbatim, and “rich, thick description” was used in the narrative to convey the setting of the study to project an “element of shared experiences” with the

reader. Finally the role of the researcher, including any bias and personal views, was disclosed (Creswell, 2003).

This section discusses each of the four research questions, presents themes that emerged, uses the literature to connect and clarify meanings, and offers interpretations of the findings.

Research Question 1. What does teacher leadership look like in a selected secondary mathematics department? Teacher leadership, as defined for the purpose of this study, is leadership for the purpose of improving the teaching and learning of colleagues. This was evident in responses by teachers, who felt sharing impacted their teaching practices. Specifically, one teacher stated, “She shares her lesson plans with me for algebra II...and I think because of that, my teaching is better.” Furthermore, one teacher felt that teacher leadership occurred “when a teacher has a good teaching idea and shares it with other people in their department and I actually see this being done quite a bit.”

The conversations and collegial talk happened on a daily basis according to most of the teachers. Mangin and Stoelinga (2008) discussed two important benefits for teachers who become leaders. First, such teachers have a direct connection to the classroom, possessing “special knowledge.” This was evident when the teachers in the math department responded that they choose to go to a colleague in their department first when faced with a question related to content, classroom management, or a student issue. Second, since teacher leaders do not have a formal power of authority, the issue of trust is used to develop and enhance professional learning. Teachers in the department expressed that they felt comfortable with each other and would have no problem “going to anyone

in the department” for help. While the term was never used formally, teachers acted as mentors due to the culture that existed. This supports Lieberman and Miller’s (2004) view that teacher leaders emerge in three roles: as researcher, scholar, and mentor. Mike’s use of the Khan Academies, flipped classroom model, and his introduction of the “trash can method” are examples of teachers using “special knowledge” and sharing best practices to affect the teaching and learning of other teachers.

Lieberman and Miller’s (2004) view that teacher leaders emerge as researchers is evident in the amount of time Mike spent investigating the Khan Academy math videos and the flipped classroom idea. Mike was quick to say that the videos are not the answer for some students, who invariably watch them with the intent of completing an assignment only, “That’s where I am right now, so I’ve got to put some thought into how I can accomplish the learning objective.” The teacher as researcher creates new knowledge through “reflective practice” according to Lieberman and Miller (2004) and again, this was also evident in the work that Grace did on Whole Brain Learning. Her research consisted of web links and personal communication with elementary teacher friends who were using the strategy. Grace felt that her student’s learning would be affected in a positive way, “There are definitely days when I see students shutting down and checking out and that doesn’t sit well with me...I do think there is just an immense learning possibility with it.”

During the department meetings, there were several times when teachers shared iPad apps and technology strategies. One interviewed teacher commented, “My best learning experience was working with the other teachers in the math department and learning how to use our iPads.” Another teacher felt that the opportunity to share “the

iPad and apps...was awesome.” The department chair’s particular strength was in using technology and much of her leadership took on a casual approach of helping others. One statement she made during a department meeting confirmed this, “If anybody needs to know how to use the Reflection program just ask me, and I’ll come show you.” As another teacher stated, “Yes, we do share; it’s realizing that no one knows everything.” Therefore, teacher leadership emerged informally, as teachers in the department shared ideas, strategies, lesson plans, and technology related issues.

Teacher leadership was evident outside of the math department as well. The concept of distributed leadership brings leaders and followers together and posits that everyone has the opportunity to become a leader in some capacity (Harris, 2003). One teacher described teacher leadership as having two components: leadership among students and leadership among peers. In the math department, Eileen was also selected as a representative for training on the Professional Learning Communities and Jane was selected to participate in the SMART Program. Mike commented that the “teachers in our department are involved in other things around the school where their leadership is pretty obvious.” One example of kind of leadership that Mike felt most important was what he termed, “Catholic leadership.” The math department’s attendance at morning mass set “a tremendous example” to others. Even though the mass was very early in the morning, and not a lot of people saw it, he felt “the students know it.”

Spillane (2005) explained that scholars tend to think of leadership practice as the “acts” of the individual leader. However, a distributed leadership theory is formed in the “interactions of leaders, followers, and their situation” (p. 149). The social context of the math department correlates to the work of Spillane et al. (2001), and The Distributed

Leadership Study, who contended that the social context is an important component in the study of “human cognition,” and that an individual’s cognition is dependent upon both the individual and the environment. This contention is important because it demonstrates how this “interdependence” is “stretched over the school’s social and situational contexts” (p. 23). A distributed theory of leadership allows then for a distribution of leaders, both formal and informal.

Flores and Robert’s (2008) study of three high school math departments showed that leadership was one of three areas of influence that attributed to gains in mathematics achievement, “Ultimately, we found that developing strong teacher leadership...and empowering teachers with the freedom to find solutions to complex learning problems was the answer” (p. 315).

Interpretation. Two themes emerged about teacher leadership. First, teacher leadership was informal, even though there was a formal department chair position, teachers took on leadership roles through sharing best practices. Using the definition that teacher leadership means improving the teaching and learning of colleagues, interview data show that the teachers in the department did affect the learning of one another. The second theme that emerged was that teacher leadership was not restricted to the math department. Each math teacher, in terms of teacher leadership, brought something unique to the school community. For example, through her years of work with Dr. C, Sunshine came to understand student learning differences and was often asked by other teachers for assistance in this area. The third component of Wenger’s Social Learning Theory, a theoretical framework of this study, is community. Community requires mutual engagement, creating relationships among people. In real life, as in the math department,

these relationships are complex; they are “mixtures of power and dependence, pleasure and pain, expertise and helplessness, authority and collegiality” (Wenger, 1998, p. 77).

The math department is a community of practice where the teachers interact, and have the “interdependence” on one another, that Spillane (2005) spoke of in his Distributed Leadership Theory.

What we do not see in the department and what is often a challenge to achieve, is teacher leadership that is transformative. Returning to Mezirow, transformational learning is dependent on a person changing their “meaning perspective” (Mezirow as cited in Taylor, 1998, p. 14). As people encounter new experiences, they will either accept or reject these experiences based on a number of factors related to a person’s personal knowledge, beliefs, and assumptions. Transformative learning occurs when a person accepts a new perspective resulting from an unfamiliar situation, known as a “disorienting dilemma” (Drago-Severson, 2007, p. 74). While teacher leadership was evident in different forms, the type of leadership needed to support transformational learning is still developing.

Drago-Severson (2008) wrote about adult development and four “pillar practices” that support transformational learning. She defined growth as “increases in our cognitive, emotional, interpersonal and intrapersonal capacities that enable us to manage better the complex demands of teaching, learning, leadership, and life” (pp.60–61). The four pillars are: teaming, providing leadership roles, collegial inquiry, and mentoring. The first pillar, teaming, consists of creating teams of colleagues to discuss, evaluate, and consider other opinions regarding curriculum, student work, instructional strategies, and philosophies on teaching and learning. Adults will “benefit from team members offering

different kinds of supports and challenges for growth” (Drago-Severson, 2008, p. 62); the opportunity to learn from dialogue stimulates the growth of knowledge. The teaming has positive effects on communication, implementing changes, leadership opportunities, and decreasing teacher isolation. Teaming is occurring in the department on the dialogue level, where some growth has been noted in teachers’ practices. The fact that Grace is learning and implementing whole brain learning techniques and Mike is flipping the classroom shows that teachers are willing to try new experiences and challenge their normal routines, but the support systems need to be in place to sustain and grow these initiatives.

Barriers to teacher leadership were discussed in the international research of Can (2009) and Muijs and Harris (2007). The research showed that the concept of teacher leadership had not been fully embraced by all stakeholders; teachers saw themselves as managers of the classroom, rather than leaders (Can, 2009). Researchers reported other barriers that included stress and resentment from the added responsibilities teacher leaders have, and the role confusion of “leader” or “administrator” due to the many administrative duties assigned to teacher leaders (Lindahl, 2008; Mangin & Stoelinga, 2008). These barriers were also noted in this study. Teacher behavior confirmed that they were more closely aligned to classroom managers versus leaders in their department. The department chair felt that more of her time was spent doing the administrative work than anything else, and the level of stress for all the teachers was very high. An interesting observation seems to be that there is disconnect between the teacher’s professional learning and teacher leadership. Teachers in the department are doing wonderful things with their professional learning, but it stops there. Is it barriers such as

communication, time, administrative support, or lack of professional development that hinder the opportunities of teacher leadership? Or, is teacher leadership hindered by the perception that leadership “equates with position or role” (p. 318)? Once leadership moves from the individual to the group, as in teacher leadership, then distributed leadership will become a reality.

Research Question 2. What are the formal and informal roles of teacher leadership within the department? The department chair position is the formal role within the math department. Jane has held this position for the last 8 years and was appointed to the position by the former school administrator. Reeves (2009) explained that formal roles are sometimes related to elected positions, explicit duties or responsibilities, as in Jane’s case. Jane said, “I feel like I’m responsible for dotting my I’s and crossing my T’s and making sure the paperwork gets turned in.” The administrative duties that Jane referred to were observed and documented in the minutes of her meetings as well.

Formal teacher leadership roles within the subject department, the department chair, head of department (HOD), master teacher, or lead teacher, are based on positional power due to their rightful authority to manage others. The combination of subject expertise and the proximity to teachers are two very important characteristics of the department chair role that make it an ideal position for teacher leadership as discussed by Siskin and Little (1995) when they stated subject expertise is a “powerful warrant for teacher leadership” (p. 52). Jane’s experience with technology and the learning that she was doing in this area set her apart from the other teachers and gave her the ‘expertise’ needed for her role as department chair. However, it has been documented that the role

of department chair is also “misunderstood” and somewhat “absent from the literature” (Zepeda & Kruskamp, 2007, p. 45). Furthermore, the roles and responsibilities remain unclear and vary widely in practice, (DeRoche et al., 1988). Research by DeRoche et al. (1988) found several results that support the “misunderstood” role of department chairs. The selection process was varied and inconsistent; compensation for the role was more intrinsic than extrinsic; and, the responsibilities mainly included managerial duties of “budget work”, ordering textbooks, class scheduling, and curriculum planning (p. 136). Jane’s responsibilities support this statement as her duties are curriculum related, textbook management, department supplies, and teacher observations. The curriculum planning was done at both school and district level meetings throughout the year. The focus at the district level was the Common Core State Standards for mathematics. In addition, the work of Weller (2001) and of Zepeda and Kruskamp (2007) established that the majority of department heads receive little or no formal training for their position, or time for handling the managerial aspects, which Jane also confirmed. The demands of additional duties put constraints on professional development and instructional supervision opportunities; Jane explained it was a struggle for her to complete the two mandatory observations per teacher that department chairs were required to do.

One theme that emerged in regards to Jane’s formal role was the culture of trust she has created in the math department. Teachers feel comfortable, appreciated, and have the freedom to make classroom and curricular decisions. While she says, she “never wanted to be a leader,” Jane has created a culture of respect and trust within her department that allows the teachers to feel they have the ability to provide help, as well as ask for help when situations arise. One teacher commented that the department chair,

“always asks us for input; she doesn’t make any decision all by herself that affects, you know, the whole department.”

Smylie et al. (2007) discussed the benefits of building such a culture. The researchers used a theoretical perspective to explain that the role of trust is a “dynamic phenomenon” that can strengthen or weaken an organization, but once the “foundation” of trust is laid, the organization can change for the better as a sense of commonality and collaboration are formed (p. 473). Trust in an organization offers several benefits: Trust can bring about an “open exchange of information,” alleviating measures of control and monitoring (p. 474). Trust creates an atmosphere of “spontaneous sociability” among members of the organization (p. 474). Common goals are in place; cooperation and collaboration are present; and a social community develops, which corresponds to Wenger’s Social Learning Theory.

Informal roles, as discussed by Reeves (2009), involve mentoring, planning, and influencing the classroom practices and professional knowledge of colleagues. The influence of informal leaders can be especially powerful due to their affiliation with their department and other teachers. York-Barr and Duke (2004) also concluded that informal teacher leaders are sometimes recognized more as a leader than those in formal, authoritative positions. This was confirmed as well by the research of Supovitz (2008) when he studied the roles of instructionally influential people within a school organization. Over 200 interviews were taken with teachers and school leaders, with specific questions to teachers about whom in the school they turn to for help in the various areas of course planning, classroom management, and student performance. In this study, it was also confirmed that teachers went to colleagues in the department for

help when they had questions about content, classroom management, or student-related issues.

Eileen stood out as an informal leader. On several occasions, she was described by colleagues as having, “the biggest shoulders for listening to something and then taking action;” it was further noted that she was portrayed as “the web that holds us (the department) together.” Katzenmeyer and Moller (2001) referred to leaders with personal power rather than positional power, “Teacher leaders are approachable and influence primarily through their personal power” (p. 7). Returning to the research of Yow (2010), as an informal leader, Eileen may be considered in the middle of “behind the scenes” and “apparent and noisy” on the continuum of teacher leadership perceptions because of her work both in and out of the department. Furthermore, Northouse (2004) stated that the majority of influential people in his study were teachers who held no formal leadership position. A theme that emerged surrounding the informal roles of leadership within the department was that teachers were informal leaders for one another. The continual dialogue at lunchtime, before school, after school, and during class exchanges provided the support needed for teachers to improve their teaching and learning.

Interpretation. Formal and informal teacher leaders, through their actions and interactions, influence the professional relationships that are formed within the department. Fullan (2002) wrote that “creating and sharing knowledge is central to effective leadership,” and knowledge is only created through a social process (Fullan, 2002, p. 18). Fullan (2002) stated that leadership and sustainability are two interwoven concepts, where one cannot survive without the other. Sustainability, according to Fullan (2002) is developed in a social environment where learning is vital and leadership at all

levels is essential. The math department, a community of practice, survives because of the continuous interaction and exchange of ideas, which are fundamental to creating meaning for their practices. The formal and informal roles are necessary to encourage the exchange of ideas and contributions, and each role creates an ‘identity’ or “self-image” that Wenger refers to in his four components of social learning theory (Wenger, 1998, p. 151). For example, Mike’s identity within the department is clearly defined by his faith and his expertise at handling the higher level math curriculum. Jane’s identity is closely aligned with her involvement and expertise with technology in the math classroom.

In consideration of improving the leadership roles, the idea of focusing on the department chair more as an instructional leader is interesting. Mangin and Stoelinga (2008), more recently, discussed the renewed interest in formal teacher leadership roles in the area of instructional leaders. Due to legislative mandates of school accountability, high stakes testing, and other school reform models, instructional teacher leadership is one initiative to increase student achievement. Content and procedural knowledge were factors contributing to the level of influence of instructional teacher leaders (Mangin & Stoelinga, 2008). At this point in time, the math department chair position attends curriculum meetings at the district level, but from there, disperses the information only, again as more of a duty rather than anything else. Does this mean that the department chair should be released of other duties to focus on instruction? What are the qualifications needed to become an instructional leader and does the current department chair have these qualities? The research of Handler (2010) discussed teachers who take on formal roles as curriculum leaders. These teachers must “demonstrate a sophisticated

understanding of education as a political and social enterprise” (p. 35). What may be needed in the math department is the opportunity for an instructional leader to use their expertise to enhance professional learning and leadership.

Research Question 3. How do teacher leaders in the department create opportunities for professional learning? Two themes emerged in response to this research question. First, teacher leaders created opportunities for professional learning during the school’s in-service programs. Second, most of the opportunities for professional learning were centered on using technology in the classroom. During the school-wide in-service program, Mike presented how to use a data template to gather information about student learning; Jane presented examples of using technology in the classroom on at least four occasions; Eileen spoke to the faculty on Professional Learning Communities; and Sunshine presented and explained the school’s program, including strategies, for working with lower level students. These opportunities were directed more at the entire faculty rather than confined to the math department. However, on an informal departmental level, teacher leaders used opportunities of random meetings during lunch, or before or after school to impact teaching and learning within the department.

Sisken and Little (1995) found that regardless of the contextual differences between and within high school departments, subject departments “are dominant factors” in developing leadership at the high school level (p. 51). The connection to subject expertise was documented as an element necessary for legitimate leadership by teachers. The research on teacher expertise informs this study about the connection between subject departments and informal teacher leaders. While Sisken and Little (1995) contend that department leadership may be strong or weak depending on the culture, institutional

norms, and formal leadership of the school, the tradition of subject departments at the secondary level to influence teachers and community is strong.

An area that seemed to present itself with many opportunities for teacher leadership was the area of technology integration. Earlier research suggested that technology can support student learning by building confidence, independence, and providing a variety of activities to ease boredom (Ruthven et al., 2009). However, it also poses a dilemma for teachers that may be fearful of technology, critical of change, and dependent on a teacher driven curriculum. The resistance to technology was evident in the department when two of the math teachers admitted that they have not used the iPad in the classroom after having it for several months. One teacher said that, “I’ve been pretty closed to the iPad...I don’t find it useful.” The same teacher, however, did request that the department chair schedule another lunchtime meeting to explain how she incorporated the technology into her classes.

Ruthven et al. (2009) stated the importance of teachers developing their “craft knowledge,” or “system of situated expertise” in the area of new technologies in the mathematics classroom (p. 281). The department chair concurred with the ease of technology when it came to posting class notes, test reviews, and having students submit work. Also, the department chair was particularly skilled in using the *GeoGebra* program and having students use it for graphing and math projects. In addition, other technologies that were being used included iPad apps and graphing calculators.

Interpretation. Teacher leaders created opportunities for professional learning by the nature of topics discussed that were related to teachers’ day-to-day practices. Whether the learning took place formally through in-service programs and workshops, or

informally through sharing and collegial talk, the fact that the learning was related to their daily practice was important. Guskey (2002) found that when teachers believed they were capable of affecting student achievement, they were more inclined to participate in professional development, more specifically the kind of professional learning that was related to their day-to-day practices and classroom instruction. It was shown in the findings of research question 2 that teachers in the math department were concerned about student learning and achievement, thus verifying Guskey's statement.

Furthermore Cohen and Ball (1999) discussed three important elements in the educational field related to professional learning. First, the learning must be about the practice, "To learn anything relevant to performance, professionals need experience with the tasks and ways of thinking that are fundamental to the practice" (Cohen & Ball, 1999, p. 11). Second, the practice must be grounded in teaching and learning, and finally, continued learning in professional communities is necessary to sustain a culture of professionalism focused on the improvement of teaching and learning (Cohen & Ball, 1999). When teachers in the department were able to present at department meetings and in-service programs, a culture of professionalism was created. In addition, Lieberman and Miller (2004) concluded that teachers' social participation, "the capacity for joint work," builds a learning community based on "collegiality, openness, trust, experimentation, risk taking, and feedback" (p. 10).

An underlying commonality for most of these opportunities was the social aspect. The teachers in the department represent a "community of practice." A community of practice, as defined by Wenger (1998), is a place where we "develop, negotiate, and share" ideas, theories, and talk; a kind of community (p. 48). Formal and informal

teacher leaders influence others through sharing, problem-solving, learning, and supporting one another in their professional relationships that are formed. Fullan (2002) wrote that “creating and sharing knowledge is central to effective leadership,” and knowledge is only created through a social process (p. 18). Printy (2008) also said that informal leaders emerge to keep the community focused and to maintain a social learning environment. Siskin and Little (1995) also noted that the strength of subject departments lie in the level of collegiality and community among members; strong departments showed agreement towards teaching and learning and strong professional networking.

The importance of creating opportunities for professional learning that are related to teacher’s day-to-day practices cannot be underestimated, and neither can the social process and ‘community of practice’ that are necessary for learning. However, according to data gathered from the National Staff Development Council report, there are additional recommendations that professional development should include: survey feedback of programs; beginning teacher mentor programs; communities and teams that target teachers’ individual needs; networking with professional organizations and universities; and resources for providing productive professional development. There are areas within these recommendations, such as using surveys and networking, that teacher leaders within this department could use to strengthen professional learning.

Barriers to professional learning existed with every member of the department. The common theme, unquestionably, was that of time. Each teacher expressed that the level of stress was high due to things such as missed days of school, their perception about the need to finish the curriculum, the overwhelming amount of information on

technology, and so much more that they wanted to do with computer apps, programs, and activities.

Another interesting observation that may be a barrier to their professional learning is the notion of math teachers thinking in ‘black-and-white’ terms. On two different occasions, teachers mentioned it specifically as a challenge to learning. For example, one teacher commented, “I think it’s hard, mathematicians are sometimes very black and white and sometimes it’s hard to deal with people who are black and white all the time, so trying to introduce new ideas can sometimes be a little challenging.” During an interview, discussion of engaging students through using personal response and points of view, prompted another teacher to say, “It’s not always easy in math to include a student’s personal view. It’s usually, ‘here’s how you do the problem, practice it, come back and show me that you can do it.’” Still another comment was, “I think a challenge is being open to how anybody else does something because you’re so used to doing it your way, so you think it’s the only way.” Professional learning can certainly be hindered when teachers are not open to the possibility of change or something new. However, the fact that several teachers were aware of this phenomenon is impressive and provides a starting point.

Research Question 4. How do teachers experience professional learning in this secondary mathematics department? Through the interview statements and observations, three themes emerged about how teachers experience professional learning in the department. When Sunshine spoke about her learning with Dr. C and Dr. T, this one-on-one experience changed her teaching and classroom management practices in such a way that the focus was shifted to the student’s learning more often. When the local university

professor was able to work with the department one-on-one with the *GeoGebra* program, Sunshine felt that she learned the most in this type of setting and Jane was able to take what she gained that day and continue the learning on her own. In addition, all the teachers commented about learning through a conversation, passing an idea along at lunch, or sharing a strategy with one another before school. In these ways, the first theme that emerged is that professional learning is experienced one-on-one in the math department.

Little's (1982) research supports that teacher collaboration is important for school success. Throughout the 19-week study, 3,190 teacher statements were analyzed that reflected teacher practices. The results indicated that successful schools have several characteristics, the first of which said that teachers engage in collegial work, "frequent, continuous, and increasingly concrete and precise talk about teaching practice" (p. 331). Another characteristic of successful schools from the research was the practice of teachers teaching teachers. Other characteristics were also identified in terms of teacher interactions and participant qualities. The most successful schools exhibited and encouraged frequent discussion of teaching practices and the sharing of teacher knowledge.

In addition, Horn and Little (2010) investigated how "teacher talk" and collegiality influenced professional learning within two urban high school subject departments. Their research concluded that conversations either turned 'toward' the teaching or 'away' from the teaching practices depending on how teachers responded to one another. If there was discussion and reflection about a teacher's specific classroom problem, then the teacher had opportunities to learn about practice and professional

learning was more apt to occur. However, if the response was different and teachers used a “show and tell” scenario, then the learning opportunity was hindered (Horn & Little, 2010, p. 211). Through interview data from this study, it was apparent that some conversations the teachers had did turn towards learning. For example, Grace discussed that when she spoke to the department chair one-on-one about the Algebra II course that they both taught, she was able to improve her teaching. With this being only her second year teaching the course, Grace was able to make positive changes because of the interaction, “For the longest time I would go through every step in the book, but also noticed that kids were shutting down. It just wasn’t working out. Our department head has been very good at showing me shorter, not necessarily simpler, versions, so I’m able to maintain their attention better.”

Professional learning was also experienced at lunch, or at a volleyball game; through reading a math journal or textbook; investigating a website, through a conversation with a student, or sitting in the back of another teacher’s class. These informal opportunities emerge as the second theme. Printy (2008) researched factors that influenced the learning of secondary mathematics and science teachers within their “communities of practice” (p. 188). Printy (2008) defined a “community of practice” as a “naturally occurring” community that comes together through mutual interests, and who also engage in activities that develop knowledge and share information” (p. 191). Printy (2008) specifically pointed to the “non-formal teacher learning” that is usually representative of priorities in educational matters. Teachers are apt to learn in the community they identify with most.

Professional learning was also experienced in formal settings of workshops and school in-service programs. Jane's participation in the SMART program provided a great deal of knowledge on using technology in the classroom; Eileen's participation in the PLC workshops provided additional teaching strategies and ideas that she was able to incorporate in her geometry classes, as did Grace. Through document analysis, the school-wide in-service programs offered professional learning on Whole Brain Research, using data in the classroom, Catholic identity, teacher examples of classroom practices, technology integration, iPad apps, fire safety and campus security, and SACS committee work. Four out five of the math teachers had opportunities to formally present a topic to the faculty at these school-wide in-service meetings. The third and final theme to emerge was that professional learning was experienced through formal opportunities. Another example is the learning that Mike experienced through attending the AP institutes for calculus and statistics. His experience was so positive that he felt returning every 3 years was necessary.

Tabernik and Williams (2010) used data from the 1995 TIMSS to show that targeting teacher's learning and knowledge is important in impacting student achievement. The mathematics teachers in their study were selected based upon their involvement in a professional development program that focused on teachers sharing resources and strategies, and developing "powerful practices" together (p. 35). The results showed that student "passage rates" increased more when teachers possessed mathematical backgrounds and participated in over 90 hours of professional learning (p. 42), "The teachers talked about the need for professional development as a means of sharing experiences with colleagues and learning new skills" (p. 44). This was also

confirmed in the research of Darling-Hammond and Bransford (2005) during their research of school reform in San Diego. At the high school level, reform slowly started once teacher collaboration increased and teachers were permitted to “model and support” teachers’ learning (p. 91).

Interpretation. The first theme discussed that professional learning occurred one-on-one in the department. While some of the talk resulted in teachers changing their practice, we must be careful not to assume that collaboration and sharing will always result in professional learning. Returning to the work of Little (1982), the first characteristic of successful schools discussed the importance of frequent collegial talk- which does seem to be happening in the math department. There are numerous examples of teachers involved in sharing ideas and collegial talk. However, without observing the math teachers’ instructional practice in the classroom, it is difficult to determine if learning has truly impacted their practice. The second and third characteristics that the research of Little (1982) defined were that teachers are frequently observed and provided useful feedback, and that teachers are involved in the curriculum planning, research, evaluation, and preparation of the material. From the data collected, it was not apparent that teachers in the math department were given feedback other than their once- or twice-a-year evaluation. The department chair and teachers were involved in the curriculum planning as far as course progression and prerequisites, course selection, and textbook input. There was a limited amount of research, other than the whole brain research, and course evaluations and preparation were not observed or noted.

The work of Wenger (1998) on social learning and communities of practice provides the theoretical framework for professional learning in the math department. Of

his four premises, knowing is a matter of participation-active engagement in the world- and meaning is ultimately what learning should create, are most important when looking at the learning experiences in the department. Whether these experiences happened informally, through conversations, reading, and research, or they happened formally in workshops, AP institutes, and programs, it is the social environment that sets the stage for learning. A community of practice, as defined by Wenger (1998), is a place where we “develop, negotiate, and share” ideas, theories, and talk; a kind of community (p. 48).

Professional learning was experienced differently for the teachers in the department. Knowles (1978) research on adult learning, termed andragogy, provides a framework for understanding how teachers experienced and sought out different learning opportunities. Merriam (2001) discussed five assumptions of andragogy, the first being that adult learners can direct their own learning. This was evident when Mike researched and began incorporating the Khan Academies into his lessons; Jane used self-teaching to increase her knowledge of the *GeoGebra* program; Sunshine went to a professor friend and observed his calculus class when she learned she would be teaching the course. The other assumption that is closely aligned with the teachers’ professional learning experiences is that adult learners have learning needs that are closely aligned with their roles in society. Each of the teachers in the department participated in the learning experience because of their role as teachers or leaders in their department.

Recommendations

Leadership and learning have the potential to impact the professional role of teachers, as well as improve teacher practices, which ultimately may result in the improvement of student achievement. As Fullan (2007) stated, “Student learning

depends on every teacher learning all the time” (p. 35). The research findings revealed that teacher learning and leadership were experienced on formal and informal levels in the selected secondary mathematics department. While the hope of this phenomenon is to build teachers’ knowledge and leadership opportunities, there still remains the need for connections. The data show examples of teachers’ leadership and learning, but how is this connected to their curriculum, to their practice, to their community? The research presented provides a chance to go deeper, to question learning and leadership and develop new definitions of these concepts. Within the heart of the organization are the people, their stories, and their daily routines that define the meaning of their community. Giving voice to the teachers and building a culture of trust may begin the process of connecting teacher leadership to transformational learning-the type of professional learning needed to affect change.

Drago-Severson suggested, “We need greater knowledge about practices that support teacher learning and growth by focusing on how teachers make sense of their experiences” (p. 71). This ethnographic study hoped to gain better knowledge into how a department of five teachers went about their daily practices and social experiences regarding learning and leadership. Underlying these experiences are the frameworks of Social and Adult Learning Theories which attempt to explain the social phenomenon that is inherently present in the learning process and what motivates adults to learn; but additionally, how can school leaders advance teacher learning and leadership within their organization?

The first recommendation considers a fairly new concept in the leadership literature-bridge leadership. Bridge leadership is defined as “a kind of epistemology in

which the leader understands that the core of his or her work is rooted in traversing spaces between people” (Boske & Tooms, 2010, p. xviii). The idea of “spaces between people” may describe the distance, or disconnect, between their professional learning and leadership and their community. Ultimately, empowering others to affect change in the community and to question the status quo is what may bring changes in teachers’ practices. It was evident that the teachers in this study engaged in professional learning and leadership opportunities, however, a sense of isolation between what they were doing and the rest of their community remained. There was no plan for how their professional learning and leadership opportunities would continue or would impact others’ practices; a need to close these ‘spaces’ was evident. Would the practice of bridge leadership close these gaps? My brief encounter with the concept of bridge leadership suggests that my formal position of authority, as principal, has the power to control and manipulate, or to model leadership that is just, equitable, and transformative. Boske and Tooms (2010) wrote that the greatest thing about an important book “is that it teaches and inspires” (p. xviii). For me, this means that I have an obligation, as a leader, to close these “spaces,” make connections, and build bridges that will give teachers voice, ownership, and power that will foster a responsibility to their community of practice.

A beam bridge consists of a horizontal beam supported at each end by piers. The weight of the beam is carried by these supports. Drago-Severson (2008) referred to the four pillar practices that support transformational learning: teaming, leadership, collegial inquiry, and mentoring. By strengthening these pillars, or supports, transformational learning will become strong enough to affect teachers’ practices. The further away the piers are in the beam bridge, the weaker the structure. In order for the math teachers to

experience transformational learning, a second recommendation-critical reflection-is needed. For teachers to change their practice, they must go through a period of unfamiliarity; they must begin to question prior beliefs, assumptions, and knowledge. Taylor (1998) identified three themes that are central to Mezirow's transformational learning: experience, critical reflection, and rational discourse. According to Taylor (1998), critical reflection is the most important aspect needed to transform a person's way of thinking. The process of questioning our beliefs and assumptions and reconsidering new ways of thinking occurs when individuals self-reflect on experiences. An earlier discussion about the math teachers thinking in 'black and white' terms, as a barrier to professional learning, is a specific example of the need for critical reflection.

Critical reflection not only has the power to change their teaching practices, but as members of a Catholic, Christian community, it has the power to go beyond the classroom- into the larger community, locally and globally. The teachers in this study embrace the school's mission and philosophy of educating the whole person; educating students to the sensitivities of others by teaching and role modeling their faith and their values. These beliefs, along with critical reflection, have the potential to extend into areas of community and global responsibility, hallmarks of social justice.

A third recommendation is the involvement of teachers in their professional life. Schools are complex; they have the power to liberate or constrain. Little (1982) found that the third characteristic of a successful school was the involvement of teachers in the curriculum planning, research, evaluation, and preparation of the material. This parallels the recommendation for teachers to use critical reflection. As an example, currently, the department chair receives and relays information to the teachers and, if necessary, a

discussion took place. Perhaps the time has come to eliminate the title of ‘department chair’ and to have all teachers take ownership for attending meetings, sharing information, and becoming involved in their professional work. The recommendation is to strengthen their practice further by having teachers work together with curriculum development, research, data analysis, and program evaluations. This recommendation follows the research of Drago-Severson (2008), using the pillars of teaming and leadership that support transformational learning.

The final recommendation is the consideration of time to develop a culture of professional learning and leadership. It was noted through the interviews that a critical barrier to teacher’s learning is time. Teachers in the department were concerned about student learning and knew of best practices that they would like to incorporate into their classrooms if only they had the time. Two teachers gave concrete examples of wanting more time to use data and the *GeoGebra* program to enhance student learning and understanding. School administration must be part of the solution for incorporating more time and support for teachers. While this is not a new discovery in education, time is one of the keys to growing professional learning and leadership within an organization.

In summary, there are four recommendations that may help strengthen professional learning and leadership:

1. The concept of Bridge Leadership should be investigated further to help school leaders empower teacher leaders. The ‘space’ that exists between professional learning and leadership needs to be closed to help transformational learning take place. Connecting leadership and learning, to sustain it beyond a presentation, beyond a workshop, and beyond a teacher’s classroom, should be the goal.

2. Teachers should use critical reflection to examine their practices.

Transformational learning, which is crucial to changing the status quo, will only occur if the teachers change their thinking from “black and white” terms to questioning their beliefs and practices.

3. Teachers should be involved with their professional work: planning, research, evaluation, and preparation of their programs. A distributed leadership practice will encourage teacher leaders to take on formal and informal roles. Teachers in this study were informal leaders for one another.

4. Time for learning must be a consideration. The data revealed that teachers felt immense pressure and stress from lack of time. The opportunity for social interaction, which will occur with additional time, is vital to learning.

Policy implications. The Common Core State Standards (CCSS) have brought education the most recent extensive reform measures to date. Currently, 45 states and three territories have implemented the standards, Florida included. This is the first attempt at producing rigorous, national standards focusing on college and career readiness. Teachers will assess students during the 2014-2015 school year in English language arts and mathematics. What are the implications for math teachers and the connection to professional learning and teacher leadership?

First, the CCSS will replace the current Florida State Sunshine Standards in mathematics, meaning all teachers will need to become familiar with and implement these standards. Second, the CCSS require unified goals and common assessments. Therefore data on student learning across the nation, in states that have adopted the standards, will become available to compare student growth and provide a more accurate

account of student achievement in mathematics. Third, there is a focus on literacy and rigor. Literacy should be incorporated across the curriculum; all disciplines will be sharing the responsibility for building vocabulary and literacy instruction into their lessons, including mathematics. Assessments are to be thought-provoking and include writing, moving away from multiple choice tests. Mathematics lessons will focus on conceptual knowledge, using real-world applications to promote deeper understanding, a return to Bloom's Taxonomy is called for. Finally, the CCSS have incorporated technology pieces into the standards to help prepare students for the global communication skills needed in today's world. Students must be able to navigate through a mass of information available through the internet, keeping in mind that creativity, teamwork, and ingenuity are top skills employers seek. The National Council of Teachers of Mathematics (NCTM) is in support of the CCSS, stating that much of the wording used is what they, as an organization, have been implementing through their own standards documents.

For teachers, professional learning and leadership are two areas that will be of high importance as schools move towards implementing the CCSS standards. Teachers will not be told how to teach the standards-this is up to the schools. Consequently, the need for teachers to collaborate, share, and discuss their day-to-day practices with one another may never have a more meaningful time than now. Teacher leaders need to be prepared to help provide a seamless transition into the standards. With their content knowledge, cultural awareness of their department, and leadership skills, they become an invaluable piece of the standards puzzle. Harris (2003) reiterated that as work demands and distributed leadership practices increase in schools, it is also necessary for

governments that are considering leadership accountability to bear in mind measures that will fairly assess a collective leadership style.

The latest TIMSS data from 2011 show that we have not made statistical gains in mathematics. Using data from Grade 8, there was a one-point difference between the U.S. average mathematics score in 2007 and the average score in 2011 (National Center for Educational Statistics, NCES). Results specific to Florida are more encouraging. According to the NCES, a higher percentage of Florida fourth- and eighth-graders performed at or above the international benchmarks (2011). However, turning to national data from the National Assessment of Educational Progress (NAEP, 2009) Florida's 12th graders are below the national average in mathematics. These data suggest a continued effort in working with math teachers on improving student achievement.

In Chapter 2, the advisory panel report, *Foundations for Success: The Final Report of the National Mathematics Advisory Panel* (NMAP) was discussed. This report, released in March, 2008, was in reply to a “presidential executive order” to examine mathematics education in the United States (Spillane, 2008, p. 638). This document signified the on-going governmental influence in education policy and practice. Spillane (2008) argued that the government has become involved in educational matters since the launching of *Sputnik*, by the Russians in 1957. The federal government has used state and local governments to carry out many of its programs, including the Elementary and Secondary Education Act of 1965 and the No Child Left behind Act of 2001 (NCLB) (Spillane, 2008). While the federal government is behind the Race to the Top and the CCSS, there seems to be more leeway for teachers to teach than previous programs, signifying the importance of teachers learning through a social environment and helping

one another. There are still many unanswered questions about the CCSS, including how will the standards be implemented and what part does the teacher play in the design of the curriculum and assessments? As schools begin the process of implementing these new policies, learning and leading as a community will be needed to create conditions for improvement to take place.

Future research. The researcher looked at the professional learning and teacher leadership experiences in a specific subject department setting. The ethnographic design of this study used in-depth interviews and observations of one high school math department. It may be interesting to consider a cross-case analysis using several departments to understand how leadership and learning are experienced across subject areas, grade levels, or teams – linking sub cultures. This research also did not include the principal, students, or other members of the school community that may influence teachers’ learning and leadership opportunities. School administrators play a major role in the professional learning and leadership opportunities afforded teachers. Students impact teachers’ learning, especially in the area of technology as was seen through the interview responses. Other school community members, including parents, impact teachers, therefore, future research warrants a need for these considerations.

Another limitation to this study was the strictly qualitative method used to understand learning and leadership amongst five teachers in a small private high school. Future research should consider a study that uses both qualitative and quantitative methods to determine if there is a correlation between teachers’ learning and leadership and student achievement. York-Barr & Duke (2004) stated, in their review of literature on teacher leadership, there is a lack of quantitative studies that show a relationship

between teacher leadership and student achievement. They stated, “Studies are largely qualitative, small-scale case study designs” and the array of teacher leadership contexts are a “major dilemma in making sense of the literature” (p. 257). To that end, future research should consider a larger, public school that looks at how teacher leadership and professional learning may influence student learning.

Furthermore, Mangin and Stoelinga (2008) discussed the renewed interest in formal teacher leadership roles in the area of instructional leaders. Due to legislative mandates of school accountability, high stakes testing, and other school reform models, instructional teacher leadership is one initiative to increase student achievement. Instructional leaders must walk a fine line as an administrator who is responsible for teacher evaluations and a colleague who is responsible for providing support, expertise in content knowledge, and assistance in teacher development. Instructional leadership was an area in this study that the department chair and teachers may need to strengthen. Technology implementation seemed to provide the best outlet for the department chair to provide support and expertise to her colleagues. Future research may consider how teacher leaders can maximize effects on teaching and learning addressing such issues by focusing on instructional leadership.

Finally, expanding the research on technology, mathematics, and professional learning is needed. Many schools are considering iPads as a way to infuse technology into the curriculum, lessen the burden of textbooks, and give students tools for the information age that they live in. Zelkowski (2011) reported that, “virtually every secondary school aged child has some sort of mobile device” (p. 40). Cooper (2012)

contended that, “83 percent of teenagers 12–17 use the Internet or cell phones for personal communication” (p. 81).

AL-Hazza et al. (2012) described iPad applications that enable students to take notes, add graphics and formulas, search the web, include voice clips, draw pictures, show videos, make presentations, and much more. The possibilities of educating students are rapidly changing and teachers are an important piece of how, and if, technology will be used. Dilemmas exist for teachers that may be fearful of technology, critical of change, and dependent on a teacher driven curriculum. However, there exists a great potential for teachers’ professional learning in the area of technology integration into the curriculum. Future research should consider investigating the connection between this learning, technology, and mathematics achievement.

Conclusions

My career as an educational leader has been very brief, but my beliefs about leadership and learning, have been shaped by this research, as well as by my personal beliefs and faith formation. This research has offered a look into the history, development, and definitions of teacher leadership from several researchers. However, I offer my own conclusions and definitions for teacher leadership and professional learning. Teacher leadership is about removing the word “teacher” and allowing leadership to be defined as *anyone* taking the opportunity to change the thoughts, the practices, and the lives of others in a positive way. I have always felt a special pull towards the underdog, and I have certainly shed a tear or two upon hearing about the many injustices we do to one another. Perhaps then, leadership is an action driven by an injustice or a sense of wanting to do something better, improving a situation. This

definition returns to the notion of changing the status quo. I know that my views on leadership are influenced by the theories of social justice and servant leadership; both take on meanings that embrace morals, ethics, and transformative leadership.

Furthermore, professional learning is about changing our perspective through an encounter, social or not, that has the potential to improve our knowledge, our well-being, and our life. Professional learning is positive growth that leads to change.

There are many factors that contribute to whether a student succeeds or not; these range from internal reasons connected to curriculum, leadership, and school structures, to external reasons involving families, support structures, or lack of, as well as the availability of educational resources. Nonetheless, research states that, “students’ learning depends fundamentally on what happens inside the classroom as teachers and learners interact” (Ball & Forzani, 2011, p. 17). I have learned from this study, however, that it is more than what happens inside the classroom; teachers can impact the learning of others through their own leadership practices outside the classroom, as well as through the interactions of individuals in conversation, role modeling, and service to others.

More specifically in mathematics, teachers’ knowledge is an important component to teacher effectiveness and improved student achievement in mathematics. Researchers agree that teachers’ knowledge of mathematics is a crucial component to improving mathematics education (Hill & Ball, 2004), as well as the leadership that is needed to move learning communities forward. The implications of this research are to improve the understanding of how teachers can learn professionally and the leadership opportunities that may affect this learning. Since school administrators, department chairs, and lead teachers are a major factor of learning and leading in a school, just by

their words, they can influence, motivate, discourage and encourage. This research hopes to inform them, through the voices of teachers, the opportunities that are within their reach of making a difference.

One of the challenges of ethnographic studies is that the researcher brings their own world-views, paradigms, and biases to the research study, leaving the data collection and analysis open to subjective interpretation. While it is difficult then to separate the “personal-self” from the “researcher-self,” qualitative studies represent “honesty and openness,” creating the humanistic approach to research that quantitative studies lack (Creswell, 2003, p. 182). For me personally, the final stages of the research were the most challenging. Just before going into the research study, my position at the school changed from teacher/dean to interim principal. This particularly presented a problem as to where I would conduct my study and the time I would be able to devote to it. Being in private education and knowing that my goal was to remain here, my choices were limited for secondary schools, resulting in the research being done in the school where I was the school leader.

The option of using other private schools in the area was also limited due to the smaller numbers of teachers in their math departments. When I look back, because of my new position, I truly do not know how I would have accomplished the same things if I had to leave the school to complete my research elsewhere. The ethnographic design of the study meant that I needed to spend as much time as possible, immersed in the math department. I felt that by having worked with these five teachers for 8 years prior, and having a personal relationship over those years, I had a better understanding of the comments, nuances, and behaviors that I observed during interviews, meetings, and

observations. One of the defining characteristics of ethnographic interviewing is the building of relationships between the researcher and the participants, and I felt I had an advantage in this area over the researcher who may be going into a school unknown. Of course, there are disadvantages as well.

It's hard not to wonder if the teachers' responses and behaviors may have been different if my role was still as teacher/dean versus interim principal. There were certainly times that I would question if they were saying that because I am the principal or was it truly how they felt. I think Heyl (2001) described it best when he said that in ethnographic studies, the researcher should realize that "only partial knowledge will ever be attained" (p. 370).

I leave the study having gained much knowledge in the area of professional learning and teacher leadership, which is invaluable to my position as principal. I have learned that to be a good leader means that I must understand all of the sub cultures within the organization. In other words, I must become a good ethnographer who is able to learn and understand how cultures interact, socialize, and share commonalities, and how trust, collegiality, and teacher learning evolve through the social organization of the school setting. The findings indicate that professional learning, supported by Adult and Social Learning Theories, occurs on many different levels-formally and informally-through relationship building and leadership practice.

A recently opportunity reinforced for me how leadership and learning, when connected and extended, can impact more than one's daily practice. I took a group of students, privileged students, I might add, to an area in the local community that suffers from poverty and homelessness. When one of the students asked me why I was driving

the bus, and not another teacher, I thought I would be providing an example of leadership that would speak to the importance of this trip, and perhaps that was so. However, it was me that took away one of the most important lessons to be learned. As the students and I left the run-down building, after preparing and serving lunch to those in need, I passed a black mother with three small children who were dressed in tattered clothes and were shoe-less. As she watched the students, clothed in their khaki shorts and polo shirts, file out of the building, she asked with a glimmer of hope, “Is this a charter school?” Sadly, I said, “No, we are from a private school,” knowing full well that her children would most likely never have the opportunity that these children did. I found this image difficult to forget. It served as a reminder of the inequities of life and my responsibility, as a leader, to encourage learning opportunities that educate students, teachers, and other leaders in ways that books and homework assignments cannot.

If my definitions of leadership and learning are based on the premise of improving a learning experience, a teacher’s practice, or another’s life in a positive way, then understanding how leadership and learning are connected, even in a small sub-culture of math teachers, may lead others to understanding this phenomenon and the potential impact the connection of leadership and learning may have, even beyond the classroom.

Appendix A
Sampling Parameters

Sampling Parameters

<i>Sampling Parameters</i>	<i>Possible Choices</i>
Settings:	Cardinal Newman High School Pope John Paul II High School, Boca Raton, FL. The Benjamin School, North Palm Beach, FL. St. Andrews, Boca Raton, FL. American Heritage, Delray Beach, FL. Kings Academy, West Palm Beach, FL. Pine Crest School, Boca Raton, FL. John Carroll High School, Fort Pierce, FL. Cardinal Gibbons High School, Ft. Lauderdale, FL.
Actors:	Members of the mathematics department Mathematics Department Chair
Events:	In-depth interviews with teachers Eating lunch with teachers Being in the mailroom before, during, or after school Department meetings In-service meetings/training
Process:	Using in-depth, formal and informal interviews to assess how teachers learn professionally-3 times throughout the study-beginning, middle, and end. Observing the culture of the department throughout the workday-mailroom, lunchroom, and professional learning opportunities. Observing teachers to see if formal/informal learning is being used to influence their practice. Who are the leaders within the department? How is leadership justified, practiced, promoted?

Miles & Huberman (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage Publications.

Appendix B
Letter to Teachers

Dear _____,

The purpose of this letter is to ask you to consider allowing me to conduct my research study within your math department. As you may know, I am presently a Doctoral student at Florida Atlantic University and am completing my dissertation on professional learning and teacher leadership. My research study is interested in understanding the culture of a secondary mathematics department and how teachers experience professional learning through informal conversations, modeling best practices, and sharing expertise. In addition, my research is interested in how teacher leadership may play a role in the professional learning.

To conduct my study, I will be using interviews, observations, and document analysis to gain an in-depth understanding of how teachers interact, learn, and lead in a departmental setting. This qualitative study will be conducted from September 1, 2012 to April 1, 2013. With your permission, I would be in your math department area, which may include the faculty lounge, department meetings, and professional development opportunities provided by the school. Confidentiality is of the utmost importance to my research. Please be assured that if you agree to participate in the study, everything-including your name, school name, school documents, and anything else that is shared-will remain strictly confidential. I assure you that sensitive issues will be minimized and the research will be published only as a dissertation. I value your time, expertise, and the hard work involved in being a teacher. I would like the opportunity to discuss this research with you and would like to contact you during the week of September 1 to set up a time that is convenient for you.

Thank you for considering being a participant in my research study. If after consideration, you are willing to participate, a consent form will be given to you to sign. The consent form has been included with this letter for your perusal.

Sincerely,

Christine Higgins, Florida Atlantic University
Faculty Advisor: Dr. Roberta Weber (561) 799-8519

Appendix C
Personal Information

Personal Information

Personal Information Sheet

Name: _____

Pseudonym: _____

Number of years teaching: _____

Number of years teaching at current school: _____

Do you have a formal position of authority in your department? _____ If yes, describe the position and the number of years in this position _____

How many teachers are in the math department: _____

How often do you meet with the teachers in your department:

formally (scheduled meetings): _____ and informally (unscheduled meetings): _____

Appendix D
Interview Protocol Guide

Interview Protocol Guide

Purpose of Study

The purpose of this ethnographic study is to explore the culture of a secondary mathematics department to understand how teachers use professional learning to affect their practice and how teacher leadership emerges within this context. The research is guided by the research questions: What does teacher leadership look like in a selected secondary mathematics department? What are the formal and informal roles of leadership within this secondary mathematics department? How do teacher leaders in the department create opportunities for professional learning? How do teachers experience professional learning in a secondary mathematics department?

Name of Interviewer: Christine Higgins

Name of Interviewee and Position: _____

Pseudonym: _____

Place: _____

Date: _____

Starting Time: _____

Ending Time: _____

Introduction:

Thank you for taking the time to speak with me today. I am interested in finding out more about how teachers learn professionally from one another and how teacher leadership may be used in this process. I am completing a research study for my dissertation and degree from FAU in Curriculum & Instruction. I have chosen the topic of professional learning and teacher leadership because I feel these two areas have the potential for impacting math achievement. My goal, through this interview, is to have a better understanding of how professional learning and leadership evolve within your

math department. I would like to assure you that everything you say during this interview is strictly confidential and will only be used for the dissertation. I will be using pseudonyms throughout my study. Is there a name that you would like me to use for you? So that I'm as accurate as possible with your information, would you mind if I tape-recorded this session? Thank you, this first interview should take approximately 40-50 minutes. I am interested in interviewing you two more times throughout the length of the study, perhaps, in the middle and then towards the end.

Interview Questions (FIRST INTERVIEW):

1.	<p>Tell me about your position within the department.</p> <p>Probe: Describe a typical day in the department. What happens during planning times? Lunchtime?</p>
2.	<p>Describe the <u>most recent</u> learning experience you had at school.</p> <p>Probe: What was beneficial about this experience? What was not beneficial?</p>
3.	<p>Describe the <u>best</u> learning experience you had at school.</p> <p>Probe: Why does this experience stand out for you?</p>
4.	<p>Tell me about your biggest challenge with professional learning in your department.</p> <p>Probe: What opportunities would help you learn more?</p>
5.	<p>Describe the leadership within your department?</p> <p>Probe: Can anyone be a leader? What opportunities are there to practice leadership?</p>
6.	<p>What are you wishing you knew more about in terms of your subject-matter?</p> <p>Probe: How do you think you could go about learning that?</p>

Closing

I would like to thank you again for taking the time to speak with me and help me have a better understanding of how professional learning and leadership evolve in your department. Again, I would like to assure you that everything you have shared with me will remain confidential. Within the next two weeks, I would like to send you the transcript of our interview for you to check that I have accurately stated the information that you have given. Feel free to make any corrections. Thank you so much for your time!

SECOND INTERVIEW

Name of Interviewer: Christine Higgins

Name of Interviewee and Position: _____

Pseudonym: _____

Place: _____

Date: _____

Starting Time: _____

Ending Time: _____

Interview Questions (second interview):

1.	When do you usually talk with your colleagues? How often do you talk? Probe: What do you usually talk about?
2.	If you have a question about a math topic that you are teaching, who do you usually go to for help? Probe: Is there anyone else that could help you? Who?
3.	If you have a student-related question, who do you go to for help? Probe: Is there anyone else that could help you? Who?

4.	<p>If you have a classroom-management question, who do you go to for help?</p> <p>Probe: Is there anyone else that could help you? Who?</p>
5.	<p>What kinds of ideas do you share with your department members?</p> <p>Probe: What kinds of materials do you share?</p>
6.	<p>What is your area of strength in regards to the mathematics curriculum?</p> <p>Probe: Why is this a strength for you?</p>
7.	<p>Give me an example of a lesson that you shared with someone in your department?</p> <p>Probe: Explain how that came about? Where did you learn it from? What happened after you shared the lesson?</p>
8.	<p>What kind of changes would you like to see in your department in regards to professional learning? In regards to leadership opportunities?</p>
9.	<p>Teacher leadership, for the purposes of this study, is defined as leadership for the purpose of improving the teaching and learning of colleagues.</p> <p>What informal roles of leadership exist within your department?</p> <p>What formal roles of leadership exist within the department?</p>
10.	<p>Describe an opportunity you have had to influence the learning of a colleague(s).</p> <p>Probe: What was the impact on you after this experience?</p>
11.	<p>How could teachers create more opportunities for learning from one another?</p>
12.	<p>What are the benefits of teachers learning from one another?</p>

THIRD INTERVIEW

Name of Interviewer: Christine Higgins

Name of Interviewee and Position: _____

Pseudonym: _____

Place: _____

Date: _____

Starting Time: _____

Ending Time: _____

Interview Questions (third interview):

1.	Describe the <u>most recent</u> learning experience you had in your math department. Probe: What was beneficial about this experience? What was not beneficial?
2.	Describe the <u>best</u> learning experience you had in your math department this year. Probe: Why does this experience stand out for you? Who initiated this learning experience?
3.	What changes could be made to improve your professional learning within the department?
4.	What changes could be made to improve leadership opportunities within the department?
5.	Who do you consider to be a teacher leader within your department? Why?
6.	Describe the culture of your math department.

7.	What kind of learning experience would help you the most?
8.	Is there anything else you can share with me about professional learning within your department? Probe: Is there anything else you can share with me about teacher leadership within your department?

Appendix E

Field Notes

Field Notes

Date:

Time:

Location:

Notes:

Appendix F
Observation Guide

Observation Guide

Date:

Time:

Location:

Reason for Observation:

People Present:

Physical Layout:

Conversation:

Body Language:

Appendix G

List of Codes Used for Data Analysis

List of Codes Used for Data Analysis

General codes for first read-through

Teacher leadership	TL
Professional Learning	PL
Formal Role-Teacher Leadership	FR TL
Informal Role-Teacher Leadership	INF TL
Professional Learning: Informal	INF PL
Professional Learning: Formal	FR PL

More Detailed Codes for second/third read-through

Catholic Identity	CTHLC
Administrative	ADMIN
Planning Time	PLAN
Lunchtime	LUNCH
Parent Issues	PARENT
Student Issues	STDNT
Student Learning	STDNT LRN
Sharing Knowledge	SHARE
In-service	INSERV
Department Meetings	DEPT
Self-Teaching	SELF
Culture of Department	DEPT CULT
Culture of the School	SCH CULT

Talk amongst teachers	TALK
Reference to research	RESRCH
Support-colleague	SUPPRT
Time constraint	TIME
Stress level/pressures	STRESS
Teacher's practice	PRCT
Technology	TECH
Adult Learning Theory	ALT
Social Learning Theory	SLT
Distributed Leadership Theory	DLT
Professional Development Day	PDD
Professional Learning Community	PLC

Appendix H
Document List

Document List

Document	Research Question Addressed
1. School Mission Statement/Philosophy	RQ 1, RQ 2, RQ 3, RQ4
2. Department Meetings-Agenda & Minutes	RQ 1, RQ 2, RQ 3, RQ4
3. Teacher's Course Syllabi	RQ 3, RQ4
4. Teacher Correspondence, Faculty Handbook	RQ 1, RQ 2, RQ4
5. Training Material used at School In-Service Meetings	RQ 3, RQ 4

Appendix I
Document Summary Form

Document Summary Form

Name or description of document:

Document #:

Date Received/Pick Up:

Event or contact with which the document is associated:

Significance:

Brief Summary of Contents:

References

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