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Investigating Teachers' Perspectives on the Impact of the Lesson Study Process on Their Mathematical Content Knowledge, Pedagogical Knowledge, and the Potential for Student Achievement

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Investigating Teachers' Perspectives on the Impact of the Lesson Study Process on Their Mathematical Content Knowledge, Pedagogical Knowledge, and the Potential for Student Achievement

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Ad majorem Dei gloriam.

To Caroline, Sydney, Clark, Mallory, and Clintt:

May you be blessed with lifelong learning.

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ABSTRACT

This mixed methods case study investigated mathematics teachers' perspectives of the effects of the Lesson Study Process on their content knowledge, pedagogical knowledge, and the potential for students' achievement. The population was 55 teachers from elementary, middle, and secondary schools in a metropolitan area. The three research questions guiding this study were: (1) What are the perspectives of teachers on the impact of the Lesson Study Process on their mathematical content knowledge? (2) What are the perspectives of teachers on the impact of the Lesson Study Process on their pedagogical knowledge? (3) What are the perspectives of teachers on the potential impact of the Lesson Study Process on their students' achievement?

Literature pertaining to constructivism, teacher professional development, and Lesson Study was reviewed. Data from surveys, questionnaires, and focus group sessions were examined both quantitatively and qualitatively to determine common categories, themes, and connections to each of the research questions.

The teachers believed that their mathematics content knowledge was positively affected in the areas of deeper understanding which led to an increase in self-confidence. The teachers also believed that their pedagogical knowledge was enhanced in the areas of planning and attention to student thinking. Finally, the teachers mentioned five areas for potential improvement in students' achievement. They included: students' increased conceptual understanding of the topics taught during the research lessons, planning lessons more thoroughly by making them relevant to the students' daily lives and planning it within the context of the state's curriculum, shifting the focus of an in-class observation from the teacher's performance to student thinking, and a similar shifting of the manner in which students are assessed—from

right/wrong answers to seeking thought processes whereby the student may correct misunderstanding.

KEYWORDS: Lesson Study, Teacher Professional Development, Mathematics Pedagogy, Mathematics Content Knowledge, Student Achievement, Professional Learning Communities.

CHAPTER ONE

INTRODUCTION

This study investigates the perspectives of teachers on a particular type of collaborative teacher professional development known as Lesson Study. The study is an exploration into the perspectives of mathematics school teachers on the effects that Lesson Study has on the following:

(1) their content knowledge,

(2) their pedagogical knowledge, and

(3) the potential for students' achievement.

This chapter discusses various components of the study: the background, the conceptual framework, the statement of the problem, the purpose of the study, and the theoretical framework, and its significance. It concludes with definitions of terms, the chapter summary, and the organization of the study.

Background of the Study

According to Phillips (2007), improving something as multifarious and culturally engrained as education must include efforts from all participants—students, teachers, and administrators. Stigler and Hiebert (1999) suggest that teachers must be the driving force behind improvements in the education system as they are in the best position to understand and propose solutions to problems faced by students. Teachers must have access to sustainable, high quality professional development in order to improve teaching and student learning. Teacher professional development in the United States, however, has long been criticized for its lack of

sustainability and ability to produce effective change in teaching and student achievement (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). Education theorists today believe that a critical component of educational reform lies in providing teachers with various opportunities and support structures that encourage ongoing improvement in teachers' pedagogy and discipline-specific content knowledge (Darling-Hammond & McLaughlin, 1999). One ground-breaking opportunity for affecting such change lies in the Lesson Study Process, a constructivist form of collaborative teacher and student learning.

The main theoretical principle of constructivism affirms that knowledge is constructed through interaction with others and is a shared rather than an individual experience (von Glasersfeld, 1995). Accordingly, constructivists stress that knowledge is constructed in response to interactions through discourse, reflection, social negotiation, and explanation. This notion supports that teachers should be engaged in processes that require them to communicate often with both novices and experts in their particular discipline. Within a Lesson Study framework, professional collaboration occurs between teachers of all level of expertise through the development and implementation of a Research Lesson (Rock & Wilson, 2005).

Another component of constructivism affirms that knowledge acquisition is an adapted function designed to organize one's experiences (Fleury, 1998). Consequently, teachers must face problems that motivate them to seek, test, and assess answers within socially collaborative environments. During the early stages of Research Lesson development, the team of teachers must work together to set a target for their students. The targets are constructed based on a gap in the students' actual development in the school and student aspiration for growth (Lewis, 2002; Wang-Iverson & Yoshida, 2005). Therefore, the teachers collaborate to focus the Research Lesson around gaps that they are motivated to resolve in the mathematics curriculum.

For constructivists knowledge is the result of active mental processing by the individual in a social context (Cobb & Yackel, 1996). The Lesson Study Process immerses teachers in multiple opportunities for reflection, analysis, evaluation, revamping of ideas, and sharing understandings with their peer teachers (Rock & Wilson, 2005). These tenets of constructivism are foundational in Lesson Study and confirm why each step of developing Research Lessons is vital to increasing teachers' discipline-specific content knowledge and pedagogy thus leading to greater student achievement.

Lesson Study: A Constructivist Form of Teacher Professional Development

Introduction

With its Japanese-based practice beginning to gain momentum in the latter half of the twentieth century, Lesson Study has crossed the globe with its constructivist underpinnings of teachers collaboratively developing lesson plans (Isoda, Stephens, Ohara, & Miyakawa, 2007). As of May 2004, more than 150 Lesson Study clusters have been formed in 32 states, 125 school districts. There are greater than 2,300 teachers involved in the United States alone (Chokshi, 2004). In addition to its growing popularity in the United States, Lesson Study clusters have formed in great number in Thailand, the Philippines, Cambodia, Laos, Indonesia, Egypt, Kenya, Ghana, South Africa, and Honduras (Isoda, Stephens, Ohara, & Miyakawa, 2007).

"The expression *Lesson Study* is a literal translation for the Japanese word *Jugyokenkyu* (授業研究)—*jugyo* means *lesson* and *kenkyu* means *study* or *research*" (Fernandez, 2002, p. 394). Lesson Study is a process that teachers utilize to systematically examine the effectiveness of their teaching for achieving desired learning goals. The process involves teachers working collaboratively to develop a small set of lessons. Working on these lessons involves planning, teaching, observing, critiquing, and revising the lessons in a continuous cycle (Fernandez 2002;

Fernandez, Cannon, & Chokshi, 2003; Lewis, 2000; Lewis & Tsuchida, 1998).

Lesson Study in the United States

This method of teacher professional development has been studied and written about extensively and is the focus of many new research projects in mathematics and science education. Gaining thrust by our national education-reform and research bodies, Lesson Study is the subject of current studies and initiatives of the National Research Council, the National Science Foundation, and the National Council of Teachers of Mathematics.

> Reflection and analysis are often individual activities, but they can be greatly enhanced by teaming with an experienced and respected colleague, a new teacher, or a community of teachers. Collaborating with colleagues regularly to observe, analyze, and discuss teaching and students' thinking or to do "Lesson Study" is a powerful, yet neglected, form of professional development in American schools. (Stigler & Hiebert 1999, as quoted in the NCTM Standards, 2000)

Within the framework of the No Child Left Behind Act are calls for reform-based teaching. Lesson Study is a natural fit for such a call. Wang-Iverson (2002), writes:

> If we truly are to leave no child behind, we need to rethink familiar practices we currently consider to be immutable. Lesson Study could help us wrap our minds around different ways of thinking and working. Why are we not able to help all our children reach a minimum level of competency? Why do we sort our eighth graders into those who are and who are not “cognitively” ready to learn algebra, while other countries focus on helping all their eighth graders learn algebra and geometry? Lesson Study, which builds upon teacher’s shared knowledge and insight, supported by research, can help us to overcome our own cognitive barrier concerning students’ ability to learn. (p. 1)

Stigler and Hiebert (1999) tout the importance of U.S. schools adopting Lesson Study into main-stream practices by hypothesizing that "if our educational system can find a way to use Lesson Study for building professional knowledge of teaching, teaching and learning will improve" (p. 131). The Lesson Study Process is a revolutionary way of classroom instruction with constructivism at its core. During Lesson Study teachers are able to gain new insights into pedagogy and content knowledge each step of the cycle by collaborating with other teachers, administrators, and others concerned with the continued improvement of student instruction and learning.

Teaching Paradigm Shift

Central to the Japanese-based method is the paradigm shift away from single teachers working individually to develop lessons. Fundamental to Lesson Study, teachers work in groups during all parts of the lesson design process thereby drawing from each others' resources for content knowledge and pedagogical techniques. Lesson Study theorists also remind teachers of the need to change from a method of "teaching as telling" to "teaching for understanding" (Lewis & Tsuchida, 1998, p. 12). Striking at the very core of constructivist education is this move away from teachers viewing students' minds as blank slates for them to write their knowledge upon. The following table illustrates key shifts in the educational paradigm.

Table 1: Lesson Study Paradigm Shift

Paradigm Shift	
Traditional Paradigm	**Lesson Study Paradigm**
Individually created lesson plans	Collaboratively planning of lessons and sharing responsibility
Teaching with the classroom door closed	Teaching with observers in the classroom
Little or no reflection (on-the-go formative assessments only)	Reflection and critique of lessons done by a group with observational notes
Short, hard-to-document looks at student work during class time	In-depth documentation of student work and how it connects to the lesson

Unlike other forms of in-class observation, students are the main focus during Lesson Study (Richardson, 2001). The teacher's teaching style and ability are not discounted, though, as students' receptivity of the lesson hinges on the teacher's ability to deliver the lesson plan as designed. Differentiating itself from other forms of collaborative lesson development, Lesson Study "makes teacher collaboration concrete and focuses on a specific goal: better understanding of student thinking in order to develop lessons that advance student learning" (Wang-Iverson, 2002, paragraph 7). Lesson Study epitomizes constructivist doctrine as they both begin by seeking out what students are lacking in their content knowledge. Only when teachers know where the gaps are in knowledge can they begin developing an environment in which students will be free to construct new knowledge. The new knowledge will be constructed by scaffolding from what they have knowledge of from previous experiences. By working together with other students and the teacher from a constructivist perspective, students will construct a greater and more lasting body of knowledge from Research Lessons collaboratively constructed by teachers focusing on real-world applications of mathematical concepts.

Lesson Study in Japan

Lesson Study began as a part of in-school teacher training or professional development in Japan known as *Konaikenshu* (校内研修) which began around 1955 (Yoshida, 1999). Key to *Konaikenshu* is goals or themes that administrators and teachers adopt for their districts and schools. These goals include, but are not limited to, developing students' academic skills. Lewis and Tsuchida (1997) report that an analysis of the words used when describing *Konaikenshu* goals showed that "autonomy" was the most commonly used word. Teachers in Japan are not required to practice any particular form of *Konaikenshu* although many see it as a factor which defines them as a professional teacher (Yoshida, 1999). Lewis and Tsuchida (1997) go on to

report that the goals are usually adopted for four to six years in order to attain significant results.

In Japanese culture, Lesson Study is the mostly commonly practiced activity during *Konaikenshu* (Yoshida, 1999). Permeating the Lesson Study cycle are ways in which the district and school goals are realized. Research Lessons are the actual classroom lessons that teachers develop during the Lesson Study cycle. The Lesson Study cycle is the lifecycle of a Research Lesson beginning with its planning by its collaborators until its final publication. Any given Lesson Study cycle centers around a group of teachers who plan, conduct, and evaluate the Research Lesson. The Lesson Study Process is cyclical and doesn't focus on a "product" at the end. Rather, the process generates new insights and investigations into the teaching and learning process (Yoshida, 2002). Inherent in the diagram is the circular nature to which the lessons are developed. Once an initial presentation of the lesson is made to students (with observers present), additional iterations of revised lessons are made on the lessons. A typical mathematics Lesson Study cycle involves open-ended problem-solving tasks for the students (Yoshida, 2002).

Lesson Study Cycles

Authors of Lesson Study cite a number of processes making up Lesson Study cycles. I have divided them into five:

1. *Development of Goals*. Fernandez (2002) recommends that groups of 4-6 teachers come together for 10-15 hours over 3-4 weeks to carefully plan a specific lesson to address one or more goals. The teachers select a Lesson Study goal and content-specific goals to focus on during the Lesson Study cycle. Mirroring the goals of *Konaikenshu*, Lesson Study goals are not limited to academic development of students. For example, a goal of the Lesson Study cycle may be to 'Create a community of critical thinkers.' Closely related to the goal, the Lesson Study goal can be more specific. For example, an associated content-specific Lesson Study goal

may be ‘How to add and subtract unlike fractions.’ As the teachers identify which goals will be covered in the Lesson Study cycle, the teachers must think about the relationship between the Research Lesson’s content-specific goals and the overarching Lesson Study goal before planning the lesson (Lewis & Tsuchida, 1998; Yoshida, 2002). The following is an example of such a goal: ‘Students will independently learn how to add and subtract unlike fractions.’ From the relation of the goals, content-specific areas are able to be focused upon, such as, ‘To explore how manipulatives can be used in helping students independently construct methods for adding and subtracting unlike fractions’ (Yoshida, 2002).

2. *Research and write the lesson plan.* Once the goals have been determined, the teachers research the lesson topic and plan the instruction. By working together, the teachers’ pool of content knowledge and pedagogical know-how is vastly grown (Wang-Iverson, 2002). With the widely available resources for teaching lessons, teachers are able to use the Internet and other forms of technology when designing the lesson. Lesson Study guidelines advise teachers to use their collaboration time wisely, working out fine details of lesson plans and handouts between meetings, while using meeting times for examination of materials, plotting general strategies, and discussion of larger issues (Fernandez & Chokshi, 2002).

3. *Presentation of the Research Lesson.* After the teachers have sufficiently developed a lesson plan, one of the teachers is selected to present the lesson to his/her class. Before the presentation of the Research Lesson begins, Lesson Study facilitators discuss how observations are done and what they should focus on. The observers pay careful attention to the students’ interaction with what is being presented. One of the Lesson Study facilitators uses audio/video equipment to record the Research Lesson presentation—providing an objective viewpoint while supplementing the future reflection on the proceedings. Watanabe (2002) writes that insightful

observation does not happen automatically but is a skill which observers must learn. Lewis (2002) cites student engagement, persistence, degree of interest, emotional reactions, and quality of small-group discussion as data important in analyzing the effectiveness of Research Lessons.

During the lesson presentation, professionals and others interested in the Lesson Study process are invited to observe the class with a careful eye focused on how students interact with the material being presented. Guided by questions and objectives for the lesson, observers document student work for later discussion. Thus, the focus of observation is not the teacher, but the students and their learning of what is being taught. Curcio (2002) instructs observers on class protocol to refrain from interfering during the lesson, but to feel free to ask clarification question of students (e.g., honing in on their cognitive processes).

4. *Round-table Colloquium for Reflection.* Before this time observers spends several minutes collecting their thoughts and compiling their notes for the upcoming "round table" colloquium. Facilitators who had previously video/audio recorded the Research Lesson presentation set up the equipment to capture what will be said during the colloquium for future reflection by the Research Lesson team. The teacher(s) who taught the lesson have the first chance to reflect on their aspirations for the lesson, and recommendations for changes. Each of the other team members take turns sharing their reflections.

5. *Revision of the lesson plan.* After the colloquium, the Research Lesson team returns to the lesson design phase, implementing the revisions resulting from the round-table discussion. Once the Research Lesson plan has been revised, another teacher in the team volunteers to teach the revised lesson to his/her class. As with the first teaching of the lesson, a round table colloquium follows the second teaching leading to the final revision of the Research Lesson plans. When the teachers feel that they have sufficiently revised the lesson plan, the team

publishes the lesson plan in the school library for the benefit of those who will be teaching the same lesson in the future. Teachers publishing exceptional lesson plans are encouraged to submit their lesson for publishing beyond the school borders—academic periodicals or for presentation at teacher-development workshops (Lewis, 2000; Lewis & Tsuchida, 1998; Yoshida, 1999).

Characteristics of Research Lessons

Lewis (2000, p. 4-6) gives five headings for characteristics shared by all Research Lessons:

1. *Research lessons are observed by other teachers*. During a Lesson Study observation, administrators, area professionals, teachers, university professors, and others interested in Lesson Study are present during the presentation of the Research Lesson where special attention is focused on how well the students understand the knowledge being presented. In some instances, Research Lesson presentations are open to interested parties from a greater area, depending on the situation such as an Open House or during an annual Lesson Study conference where experts in the field give lectures on the latest developments in the field. The conferences conclude by an observation of an actual Lesson Study and the following colloquium (Lewis, 2000; Yoshida, 2002).

2. *Research Lessons are collaboratively planned*. Lesson Study teams begin developing a Research Lesson as soon as the objectives of the lesson have been agreed upon. During the meetings the teachers discuss reform-based teaching topics such as "how to shift toward a 'problem-solving' approach in mathematics," refining the examples used to introduce the lesson's topic and designing manipulatives and activities that provide "a better window into student thinking" (Lewis, 2000, pp. 4-5). As teachers work together in the lesson plan design

process, they are given an unprecedented opportunity to work together to create the most effective environment where students will be able to naturally construct their own knowledge. "When [the team of teachers] decides that asking productive questions was a key, the teachers came up with strategies designed to encourage questioning [by their students]" (Lewis & Tsuchida, 1998, p. 14). By ironing out leading, open-ended questions to use within the lesson, the students are ensured opportunities for knowledge construction.

3. *Research Lessons are designed to bring to life in a lesson a particular goal or vision of education.* In our study, the faculty members associated with the particular Research Lesson choose the theme or focus. The topic for the Research Lesson is one typically difficult for students to grasp and/or for teachers to teach. By focusing on only one Research Lesson per year, participating in *Jugyokenkyu* gives teachers a unique opportunity to devote unprecedented attention to improving portions of their curricula that would otherwise remain challenging for all involved (Yoshida, 1999).

4. *Research Lessons are recorded.* During each phase of a cycle, all members participating in Lesson Study are potential candidates for having their words or actions recorded. From the initial collaborative meetings with the teachers developing the lesson plan to the support members participating in the colloquium after the final presentation of the lesson—including the students and their work in between—all phases of the cycle are recorded using one medium or another. Using today's technology, the process may be recorded using audio/video equipment, observational notes, copies of lesson plans, and students' work depending on the issue of focus for the members involved. Student work is also generally collected and analyzed during the Lesson Study Process (Lewis & Tsuchida, 1999). Lewis (2000) points out that some observers within the school may be asked to collect certain types of data.

5. *Research Lessons are discussed*. A colloquium of the teacher-presenter and observers takes place shortly after each of the lesson presentations. As the observers discuss particular points of the lesson presentation and student receptivity of the lesson, areas for success and improvement are noted for special attention for the next revision of the lesson. After a second iteration of the cycle, the lesson plan may be published for the benefit of other teachers.

Conclusion

In summary, constructivism is deeply embedded within the Lesson Study framework as they both begin by seeking out student needs. Once the Lesson Study team analyzes and identifies areas where students need to improve, teachers are able to build an environment in which students will be free to construct new knowledge. Students build this new knowledge by making connections to what they already know from schema developed previously in the spiral curriculum. Through interaction with the teacher and their peers, students would be able to construct a greater and more lasting body of knowledge that results from Research Lessons.

Theoretical Framework

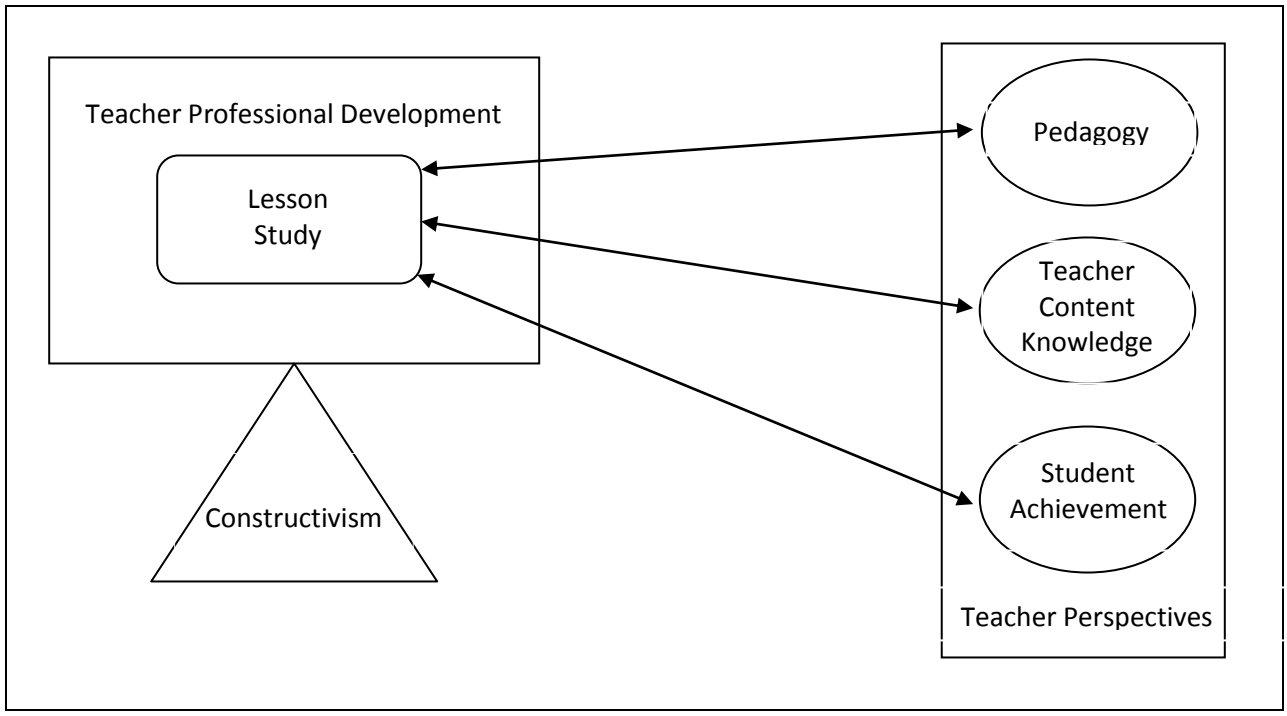
Based on the comparisons that have arisen in the past decade on student mathematics achievement in Japanese schools versus schools in the United States (ED, 2008; PISA, 2006; Phillips, 2007; Stevenson & Stigler, 1992; TIMSS, 2004, 2008), those concerned with improving the state of schools in the United States might consider Lesson Study, a sustained form of teacher professional development in Japan, as a model from which teachers in our country could learn a new system for teaching and learning. Rock and Wilson (2002) caution not to advocate implementation in the United States simply because it is supported by Japanese teachers. Instead, they insist that there must be a sound theoretical foundation to support the

implementation and use of Lesson Study since theory offers a critical rationale for answering "Why?" when promoting suggestions and guidelines from any particular model. They believe that "the general theory of constructivism, with an emphasis on social constructivist ideals, provides a framework that supports the use of the Lesson Study Process as a potential method for increasing teacher professional knowledge and development" (Rock & Wilson, 2005, p. 2). Therefore, student achievement in Japan may indicate that this method of teacher professional development may be an effective form of teacher development practice. Hence, the purpose of this study is to investigate whether teachers feel that participating in Lesson Study improves their teaching and the achievement of their students which I discuss more fully in the next section.

Conceptual Framework: Lesson Study and Constructivism

The conceptual framework of this study focuses on three major tenets: Constructivism as the philosophical-epistemological foundation theory of teaching and learning; Teacher Professional Development where teachers are continuously engaged in the strengthening of their teacher practices (e.g., discipline-specific content knowledge and pedagogy); and Lesson Study, a specific type of teacher professional development based on constructivist tenets. I believe that teachers' perspectives of the effectiveness of Lesson Study on their pedagogy, content knowledge, and student achievement are directly impacted by Lesson Study, and the outcomes of the Lesson Study Process is influenced by the teachers' pedagogy, content knowledge, and level of student achievement.

Figure 1: Conceptual Framework Diagram



Statement of the Problem

Although supporters and scholars of Lesson Study believe in the theoretical positive effects it has on teaching and student achievement (Lewis, 2002; Richardson, 2000; Watanabe, 2003; Yoshida, 2002), few studies in the United States aimed at determining whether the effects actually do exist. Therefore, the problem remains an open question as to whether teachers believe that their pedagogical skills and content knowledge and student achievement are affected by participating in the Lesson Study Process.

Purpose of the Study

The purpose of this study is to investigate whether teachers believe that the Lesson Study Process affects their content knowledge, pedagogical knowledge, as well as the potential for student achievement.

Research Questions

The omnibus question of the study is this: What are the teachers' perspectives of the Lesson Study Process on teaching and student achievement? This question inquires about two topics: teaching and student achievement. Under the umbrella of teaching are two components: discipline-specific content knowledge and discipline-specific pedagogical knowledge. In the case of this study, the discipline being studied is mathematics. Therefore, the specific research questions guiding this study are the following.

A. Questions related to teaching:

   1. What are the perspectives of teachers on the impact of the Lesson Study Process on their mathematical content knowledge?
   2. What are the perspectives of teachers on the impact of the Lesson Study Process on their pedagogical knowledge?

B. Question related to student achievement:

   3. What are the perspectives of teachers on the potential impact of the Lesson Study Process on their students' achievement?

Significance of the Study

As Yoshida (1999) points out, the Japanese culture is given credit for the development of Lesson Study although its theoretical roots are traced back to early twentieth century theories in American education. Therefore, further knowledge of the impact of Lesson Study in American schools is imperative for its expansion as a valuable form of teacher professional development. Moreover, exploration of the effects of Lesson Study on student achievement is of upmost concern for those who are devoted to finding ways of increasing the achievement of our students in America to compete in global markets. As this particular study focuses on the teachers' perspectives on the effects of Lesson Study on mathematics education in this metropolitan area, it provides opportunities for other studies to compare and contrast Lesson Study results for the goal of enhancing teacher professional development.

Implications for Policy and Practice

In many teacher professional development programs in the United States, teachers are given a workshop aimed at correcting weak pedagogy rather than participating in a sustainable program geared toward improving skills that they feel are necessary to meet the educational needs of their students (Choy, Chen, & Bugarin, 2006; Fiszer, 2004). Lesson Study is designed as an ongoing and sustainable form of professional development where teachers collaboratively plan one or two lessons per year aimed at increasing student achievement. The lesson topics the teachers choose concern areas in the curriculum students have shown difficulty understanding. As a team of teachers work together on the development of one lesson at a time, the base of content knowledge and pedagogy skills required for teaching the specific lesson grows with the level of expertise the teachers bring to the group as well as the research teachers related to the lesson. With the group of teachers spending a considerable amount of time developing the

Research Lesson, Lesson Study scholars believe that each of the teachers' teaching improves thus paving the road for an increase in student achievement (Chokshi, 2004; Lewis, 2002; Richardson, 2000; Watanabe, 2003; Yoshida, 2002).

To date little research has been done to confirm that teachers believe that their skills or the achievement of their students have been affected by participating in the Lesson Study. This study paves the way for further investigation associated with Lesson Study. A review of literature relevant to Lesson Study as a constructivist form of teacher professional development is presented in the next section where I attempt to provide a more in-depth definition as well as theoretical underpinnings of Lesson Study.

Definitions of Terms

For the purpose of this study, the following terms are defined as they relate to the meanings used in this inquiry:

Idea Units

Lincoln and Guba (1985) refer to identifying "*units* of information that will, sooner or later, serve as the basis for determining categories" (p. 344). For the purpose of this study, I will refer to these as *idea units*. Idea units are paragraphs, sentences, paragraphs (Merriam, 1988), one-word responses to questions relating to one topic.

Jugyokenkyu (授業研究)

The Japanese word meaning "Lesson Study" (Yoshida, 1999). Wang-Iverson (2002) translates this word as meaning "Research Lesson." For the purpose of this study, *Jugyokenkyu* will refer specifically to Lesson Study; Research Lesson will have a different meaning (see below).

Konaikenshu (校内研修)

The Japanese word referring to in-school professional teacher development (Yoshida, 1999).

Lesson Study Process

A form of Japanese-based teacher professional development where teachers work collaboratively to develop lesson plans for units typically difficult for students to understand. The Lesson Study Process involves planning, teaching, observing, critiquing, revising, and publishing the lessons in a continuous cycle (Fernandez 2002; Fernandez, Cannon, & Chokshi, 2003; Lewis, 2000; Lewis & Tsuchida, 1998).

Meaningful mathematics

Mathematics problems carefully structured so that they relate to students in real-world situations by demonstrating practical application of concepts being presented.

Perspective

When *perspective* is used in this study, it is describing how teachers feel, believe, or think about something; they are describing something from their point of view. Listed as a synonym for perspective, the Merriam-Webster defines *point of view* (2008) as "a position … from which something is considered or evaluated." For the purpose of this study, I will use the term *perspective* in this manner.

Professional development

A concept of lifelong learning aimed at training professionals in order that they might remain current with changing technology, pedagogy, and other discipline-specific practices (Choy, Chen, & Bugarin, 2006; Guskey, 2000).

National Council of Teachers of Mathematics (NCTM)

An organization composed of classroom teachers, supervisors, educational researchers, teacher educators, university mathematicians, and administrators involved in the mathematics education of students. It is the national body responsible for publishing the *Principles and Standards of School Mathematics* (1989, 2000), the *Curriculum and Evaluation Standards for School Mathematics* (1989), the *Professional Standards for Teaching Mathematics* (1991), and the *Assessment Standards for School Mathematics* (1995).

Research Lesson

The lesson teachers focus on developing during the Lesson Study Process.

Research Instruments (*Instruments*)

Although the word *instruments* is typically used in quantitative studies, its implication in this study describes all of the means of collecting data in this study—the focus groups, the surveys, and the questionnaires.

Research Lesson team

The team of teachers working together to develop, teach, revise, and publish the lesson plan for the Research Lesson.

Scaffolding

The term scaffolding was developed by Bruner based on the work of Vygotsky's *Zone of Proximal Development* (see below). Scaffolding refers to the steady withdrawal of adult support as a function of a child's increasing mastery of a particular task.

Schema

A term coined by Piaget to describe the framework that our brains develop to make sense of new information presented to us (Geist, 2009). Without proper development of schema, learners will be unable to correctly comprehend what they are attempting to learn.

Teaching

In addition to the traditional definition of teaching as the practice of a professional teacher, for the purpose of this study, I refer to teaching as an umbrella under which content knowledge and pedagogical skills are situated. Therefore, when referring to aspects of my research, I may use the word "teaching" as means of indicating content and pedagogical knowledge.

Zone of Proximal Development (ZPD)

A concept of learning developed by social constructivist Lev Vygotsky. ZPD is the difference in what a learner can do without assistance and what s/he can accomplish with assistance of a teacher or peer (Vygotsky, 1978).

Chapter Summary

Frequently in many teacher professional development programs in the United States, teachers are given a brief workshop aimed at correcting weak pedagogy rather than participating in a sustainable program geared toward improving skills that they feel are necessary to meet the educational needs of their students (Choy, Chen, & Bugarin, 2006; Fiszer, 2004). Lesson Study is an ongoing and sustainable form of professional development where teachers collaboratively plan one or two lessons per year aimed at increasing student achievement. The lesson topics the teachers choose concern areas in the curriculum previous students have shown difficulty understanding. As a team of teachers work together on the development of one lesson at a time,

the base of content knowledge and pedagogy skills required for teaching the specific lesson grows with the level of expertise the teachers bring to the group. With the team of teachers spending a considerable amount of time developing the Research Lesson, Lesson Study scholars believe that each of the teachers' teaching improves thus paving the road for an increase in student achievement (Chokshi, 2004; Lewis, 2002; Richardson, 2000; Watanabe, 2003; Yoshida, 2002).

To date little research has been done to confirm that teachers believe that their skills or the achievement of their students has been affected by participating in the Lesson Study. This study paves the way for an investigation into payoffs associated with participating in Lesson Study. A review of literature relevant to Lesson Study as a constructivist form of teacher professional development is presented in Chapter Two where I provide a more in-depth definition as well as theoretical underpinnings of Lesson Study and explain how the process shows promise in increasing teacher content knowledge and pedagogy and student achievement.

Organization of the Study

There are five chapters in this dissertation that discuss specific sections dealing with teachers' perspectives of the effects of Lesson Study on their teaching and student achievement. Chapter One begins with a broad introduction outlining what I intend to study. This is followed by the background of the study, the conceptual framework, the statement of the problem, the purpose of the study, and the theoretical framework. Then I discuss the delimitations of the study, the significance of the study, and possible areas of bias. Lastly, I provide definitions of terms, the chapter summary, and the organization of the study.

Chapter Two presents the literature review of the study with its conceptual framework and theoretical perspectives. This contains three main sections on constructivism, teacher professional development, and Lesson Study. Each section begins with an overview of the area and ends with a summary.

Chapter Three describes the methodology for this study. The chapter discusses the following: The design of the study, the research questions, the instrumentation, a description of participants, methods for participant selection, procedures of the study, methods of data collection, limitations, measures of bias monitoring, data analysis procedures, validity, reliability, and a summary of the chapter.

Chapter Four presents the findings of the study. In this chapter are the following sections: Quantitative findings by research question, a summary of the quantitative findings, information about the qualitative findings, a description of the focus group participants, an explanation of their potential bias, the quantitative finds by research questions, and a chapter summary.

The final chapter ends the study with conclusions and recommendations. In this chapter I have included a restatement of the purpose of this study, the research questions driving this study, the methods, procedures, data analysis, and summary of findings. I also have included a section discussing the findings, current research, and considerations for future research. Finally, I conclude the dissertation with a summary of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This review of related literature begins with a historical account of mathematics education in the United States from the middle 1900s up to today and how the events of the 1950s led to a reprioritization of the country regarding K-12 education. I then discuss the education reforms that were in the spotlight in the 1980s. This leads to a discussion of a paradigm shift that is beginning to take place in mathematics education with the publication of the National Council of Teachers of Mathematics' (NCTM) *Principles and Standards* in 1989.

The *Principles and Standards* give new vigor to a constructivist way of teaching students. Teachers are encouraged to create learning environments where students are allowed to construct their own knowledge through working with each other, the teacher, and with hands-on activities while moving away from a solely direct-instruction or lecturing type of environment for teaching mathematics. An increased conceptual understanding of the lessons in a mathematics curriculum—based on constructivism—is the thrust behind these initiatives.

In order to better understand constructivism—a tenet of the Lesson Study Process—I discuss an overview of constructivism and several constructivist theorists who have played important roles in the development of education and cognitive theories. To conclude the discussion on constructivism, I include a section on the educational implications from constructivism and narrow the field down more by discussing implications for constructivism for mathematics education.

The second major theme discussed in this literature review is teacher professional development. I have included sections on its importance, its failings, some positive reforms in teacher professional development, characteristics of successful teacher professional development, and cultures conducive to improved teacher professional development.

Lastly, I discuss the current research that has been done since Lesson Study was brought to the United States from Japan, including the findings of scholarly articles and doctoral dissertations. I also include a section listing various Lesson Study groups around the country.

Mathematics Education in the United States:
Mid Twentieth Century Forward

With the medals of victory of the Second World War hanging proudly among the country's trophies, the United States of America entered into a period of time where leading many of the world's markets presented unanticipated problems. In some sense, the victory in World War II gave us a false sense of comfort making us academically lazy for the following several decades.

On October 4, 1957, the U.S. awoke from this fairy tale land of security with the Soviet Union's launching of Спутник, known to us as Sputnik (Dickson, 2001). Indicating its successful launching into outer space, the transmission of Sputnik I's radio waves signaled to the United States a feeling of embarrassment and anxiety over its failure to retain the first-place position as the nation of greatest innovation and invention (National Public Radio, 2007). Not only were the Russians the first to launch the satellite into orbit, but they did so in the wake of failed attempts by the United States (Dickson, 2001). Pinar (2004) writes that Sputnik focused the nation on a systemic problem in the education system—that for the first time, the American

nation realized that our lackadaisical approach to education lead to our being outworked by conscientious, dedicated Russian students. While families in the American nation were growing by what would later be referred to as the baby boom, other nations were focusing their attention on how to lead the world in technology. In April 1983, the National Commission on Excellence in Education published the following:

> If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves. . . .We have, in effect, been committing an act of unthinking, unilateral educational disarmament. (p. 7)

Congress responded the following year with legislation culminating in the establishment of the National Defense Education Act, increasing funding for education at each level (Dickson, 2001). Although faced with the daunting realization that Eisenhower's budget would no longer be balanced, the $1-billion law paid for college students' loans, scholarships, and scientific equipment for public and private schools (National Public Radio, 2007). "Reflecting its origin in the Sputnik furor, the act emphasized the study of math, science, and foreign languages" (Dickson, 2001).

Starting with this point in history, the United States began initiatives toward curriculum reform aimed at making students in the United States proficient enough to out-perform their peers in every other nation in the world on standardized testing. This goal is echoed in the *No Child Left Behind Act* aimed at raising the level of student competency when receiving a public education (United States Department of Education, 2001) and Obama's stimulus plan for education (ARRA, 2009).

The State of U.S. Education: The 1980s to Present

Until the creation of the U.S. Department of Education (ED) in 1980, the revamping of education and its curricula were more topics of discussion rather than action (ED, 2007). In 1983, ED's National Commission on Excellence in Education published the report, *A Nation at Risk: The Imperative for Education Reform* (American Institute for Research, 2007, November). Heralding the call for an immediate need to reform our educational practices, its authors wrote:

> Our Nation is at risk. Our once-unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world. . .We report to the American people that while we can take justifiable pride in what our schools and colleges have historically accomplished and contributed to the United States and the well-being of its people, the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur—others are matching and surpassing our educational attainments. (The National Commission on Excellence in Education, 1983, April, p. 7)

Made widely successful by its coverage by the media, this report commissioned by President Reagan helped mobilize the public to rally around education reform (American Institute for Research, 2007, November). This rally is still being called for today. The 2008 president of NCTM was recently quoted as saying that, "at a time when maintaining our nation's competitive edge means encouraging more students to consider math- or science-related majors and careers" we must "address the challenge by moving more students into higher levels of mathematics" (Fennell, 2008, p. 3).

A Nation at Risk and the other education reports of the early 1980s helped launch the first

> wave of educational reforms that focused on expanding high school graduation requirements, establishing minimum competency tests, and issuing merit pay for teachers. (Vinovskis, 1999, p. 11)

Around the middle part of the 1980s, other government and non-government agencies began working toward an overhaul of the current educational curricula in the United States. In 1986, the Board of Directors of the National Council of Teachers of Mathematics (NCTM) established the Commission on Standards for School Mathematics as one means to help improve the quality of school mathematics. The 1989 document resulting from the commission's efforts contained a set of standards for mathematics curricula in North American schools (K-12) and for evaluating the quality of both the curriculum and student achievement (NCTM, 1989). A document published by The National Commission on Excellence in Education (1983) states that these standards are one facet of the mathematics education community's response to the call for reform in the teaching and learning of mathematics. The *Standards* reflect, and are an extension of the community's responses to those demands for change, specifically, what is considered fundamental knowledge versus what is not. Permeating throughout the *Standards* is a consensus that all students need to learn more and that instruction of mathematics must be significantly revised.

In 2000, NCTM revised its proclamation that continues to formally shift the paradigm of mathematics epistemology and pedagogy. With its new document, *Principles and Standards for School Mathematics (Principles and Standards)*, the NCTM continued redefining standards for content, teaching, learning, and assessing K-12 programs of mathematics. This revision of the initial document includes a technology principle that was not highlighted as precisely in the first. As technology is the driving force in today's world, the NCTM included a specific principle that

would articulate the need for this critical facet to be included in the nation's curriculum of mathematics.

Pedagogical Paradigm Shift

Contained within the *Principles and Standards* is the epistemological pedagogy stating that students learn by constructing their own understanding based on new experiences that enlarge the intellectual framework in which ideas can be created (NCTM, 2000). Consequently, each individual's knowledge of mathematics is uniquely personal. Mathematics becomes useful to a student only when it has been developed through a personal intellectual engagement that creates new understanding. "Much of the failure in school mathematics is due to a tradition of teaching that is inappropriate to the way most students learn" (National Research Council, 1989, p. 6). Contrary to more lecture-centered means of transferring knowledge from teacher to students, research shows that students learn more when able to collaboratively construct through interaction with their peers and teachers (National Research Council, 1989).

> Teachers' roles should include those of consultant, moderator, and interlocutor, not just presenter and authority. Classroom activities must encourage students to express *their* approaches, both orally and in writing (National Research Council, 1989, p. 61).

The NCTM (2000) maintains that students must become autonomous learners rather than teaching students to memorize facts, figures and formulas by rote. "Students learn more and better when they take control of their own learning" (NCTM, 2000). When students are able to construct their own knowledge whether by experiencing it in nature or through hands-on manipulatives, they are able to make a strong connection with deeper impression for student learning. Rote memorization has its place in mathematics classroom, although many students respond more positively to hands-on/minds-on interaction with each other, nature, and with the

teacher. "Excessive emphasis on mechanics of mathematics not only inhibits learning, but also leads to widespread misconceptions among the public concerning strengths and limitations of mathematical methods" (National Research Council, 1989, p. 44).

With this understanding of teaching mathematics, the paradigm not only shifts away from a less efficient method of teaching mathematics by lecture only, but also includes a shift away from a negative reaction towards answers generally accepted as incorrect. Inherent to the notion of students' constructing their own knowledge is that they may construct knowledge poorly. Rather than the answer's being judged as incorrect, the teacher's role shifts from judge and jury to one of discovering the thought process of the student so that a better, clearer construction can be made. The National Research Council (1989) echoes this:

> Mathematics instruction must not reinforce the common impression that the only problems amenable to mathematical analysis are those that have unique correct answers. Even more, it must not leave the impression that mathematical ideas are the product of authority or wizardry. . . .There is no place in a proper curriculum for mindless mimicry mathematics. (p. 44)

While this may come as no shock in today's world for those who have a background in pedagogy, research shows that rather than employing teaching methods learned in pedagogy courses, most teachers teach mathematics as they were taught, not as they were taught to teach (National Research Council, 1989). Instead of allowing future teachers to rely on more primitive means of teaching mathematics to students (e.g., drill-and-kill, strict lectures, using only examples in textbooks), mathematics methods courses must be designed in a way that will teach future teachers how to spread enthusiasm to their students by actively engaging them in the learning process. Through the use of real-world examples of how mathematics is used in

everyday life, students will construct more lasting connections from previous schema to the new concepts being presented during the lesson. This has implications for this study inasmuch as teachers will be asked to discuss their perspectives of the importance of relevant, real-world applications of mathematics content in their classrooms and if this has an impact on student achievement.

Constructivism

With its roots in both philosophy and psychology, constructivism is an epistemological-pedagogical method which holds that learning should build upon knowledge that a student already knows (schema). As it relates to education, constructivism describes how one comes to have knowledge of something (von Glasersfeld, 1995) as well as an indication to teachers about the necessity for them to build environments where students are able to construct new knowledge based on what they learned previously (Reys, 2007). From a purely philosophical standpoint, constructivism is based on subjectivism and relativism whereby one's reality may exist separately from experience (reality can only be known through experience) resulting in a reality particular to the individual knower. From the pedagogical end of the spectrum, "educational research offers compelling evidence that students learn mathematics well only when they *construct* their own mathematical understanding" (National Research Council, 1989, p. 58).

The construction of knowledge is an ongoing, dynamic process that occurs when the learner is presented with a situation that does not mesh with current knowledge structure. The construction of new understanding is stimulated by a problem situation that disturbs the individual's current organization of knowledge (Stiff, Johnson, & Johnson, 1993). This "disequilibrium" occurs when one's "current cognitive structures do not adequately solve, explain, predict, or allow for navigation within the situation encountered. These perturbations

are what lead to mental activity and a modification of previously held ideas to account for the new experience" (Simon & Schifter, 1991, p. 310). Key to the teaching of constructivists is that learning results from self-organization (von Glasersfeld, 1989). Constructivists teach that the means of construction include cognitive structures that are inborn (Chomsky, 1968) or are products of developmental constructivism (Piaget, 1953). A major tenet of constructivism is that new learning must be integrated with the existing schemas of the learner (Prevost, 1993), using the individual's experiences as a foundation (Jonassen, 1990). Constructivists test statements claiming to be knowledge-statements by translating them into testable operations. Presented with a problem, the subject forms a question and a solution, translates the idea into testable operations and confirms or denies the idea on which they were based, and if the idea does not mesh with existing mental structures, learners construct new relationships to accommodate the new knowledge (Stiff, Johnson, & Johnson, 1993).

In 1990, Ernst von Glasersfeld proposed four essential epistemological tenets of constructivism:

1. Learners do not passively receive knowledge through the senses or by way of communication, but rather, actively create or invent (construct) it;
2. Cognizing subjects (learners) actively build new knowledge upon from schema;
3. The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability; and
4. Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.

This method of learning and coming to have knowledge of something surfaces in writings as early as the sixth century before the birth of Christ in the writings of Xenophanes (Baird &

Kaufmann, 2003) but did not have much bearing on education until the beginning of the 20th Century with the writings of John Dewey, taking on specific prescriptions to education from the writings of Jean Piaget and Ernst von Glasersfeld. As we approached the new millennium, constructivism continued to draw much attention to itself and is nowadays considered important for a more conceptual understanding of mathematics and other subjects whereby students are able to apply the concepts learned in the classroom to various situations. In the following sections I will discuss the various theorists with constructivist notions and describes how the theory of constructivism is necessary for creating knowledge in the field of mathematics.

The NCTM *Principles and Standards* and *Professional Standards for Teaching Mathematics* is consistent with the theory of constructivism. With its revision of the *Principles and Standards* (2000), the NCTM reemphasizes its commitment to the importance of student involvement, connections and relationships in mathematics, recognition of patterns, varying forms of assessment, and the creation of a mathematical environment that encourages introspection, reflection, and classroom dialog (NCTM, 2000).

Theorists of constructivism tout that the building of knowledge (i.e., learning) is done internally by the learner using cognitive structures (von Glasersfeld, 1974; Confrey, 1990). They maintain that the new knowledge is actually an adaptation of information that the learner knew about the world around him (Prevost, 1993).

Constructivists champion the idea that knowledge is constructed by the knower, therein departing from a Cartesian conception of the mind and self. According to Descartes, the human mind is an ontological given, a *res cogitans* (a thing that thinks) with a separate existence from *res extensa* (the body and the material world in their own right). The mind, as Cartesians saw it, was an entity with an independent existence capable of logical reasoning. On the other hand, for

constructivists, "the 'I', the agent that does the constructing, is itself a construct" (von Glasersfeld, 1993, p. 27). Furthering the divide between traditional philosophers, von Glasersfeld (1993) says that the obvious circularity in this argument is something which does not worry cyberneticians. The constructivists have therefore relinquished all metaphysical realism in its totality and agrees with Piaget when he says that "intelligence organizes the world by organizing itself" (von Glasersfeld, 1984, p. 24). This has implications for this study inasmuch as teachers will be asked to discuss their perspectives of the importance of creating environments for students to construct their individual knowledge of the material such that student achievement may be increased.

Early Theorists with Constructivist Overtones

Constructivism is a term widely used in many disciplines and should be used with caution. For the purpose of this dissertation, we will deal with constructivism in its general form and use as it is within the field of education. I describe some of the different foci of the theories. In this section I have attempted to describe some of the different variations on the constructivist theme from an historical perspective, which may shed light on the development on the use of the term. When appropriate, particular emphasis will be given to mathematics education, due to its influence in this field as well as the focus of this work.

Xenophanes of Colophon (c. 560-c. 478 B.C.)

The history of constructivism can be traced back as far as Ξενοφάνης, a 6th century B.C. pre-Socratic Greek philosopher (Baird & Kaufmann, 2003; von Glasersfeld, 1990a). After discussing what it means to be a skeptic, von Glasersfeld applies Xenophanes' key assumption that whatever ideas or knowledge we have must have been derived in some way from our

experience. He goes on to derive that "if this is the case, we have no way of checking the truth of our knowledge with the world presumed to be lying beyond our experiential interface, because to do this, we would need an access to such a world that does not involve our experiencing it" (von Glasersfeld, 1990a, p. 20). Xenophanes says that we actively construct our individual realities by the mind. These realities are mediated by interpretive frameworks, or framed by appearances or semblances (Olssen, 1996). In short, von Glasersfeld echoes Xenophanes' epistemological philosophy that the only way we can know what the world is like is to experience it for ourselves.

Michel de Montaigne (1533 – 1592)

Two millennia later a Frenchman named Montaigne wrote "la peste de l'homme c'est l'opinion de savoir (the plague of man is the conceit of knowing)" (Frame, 1969, p. 33). He was not indicating that we ought to give up all knowing, but that we should look within ourselves for instruction and guidance—though not in the same way as the Socratics and skeptics had envisioned when writing about knowledge coming from within. Plato and his followers believed that at birth we were all endowed with all Knowledge and that through contemplation we have the ability to remember this Knowledge of the Forms. This is lucidly stated in Plato's dialogue of *The Meno*, in which the Menon and Socrates discuss the problem of how a concept might "trigger" its learning before the concept has been learned. (Plato, c. 370 B.C./1956). Montaigne believes that we must have an established, inner pattern in order to test and judge our actions: "the first step toward knowledge and wisdom is self-study" (Frame, 1969, p. 33). Later in *The Meno*, one might argue that Plato speaks in favor of our having a "learning paradox" (Orton, 1995, p. 215) arising from the fact that, in order to learn something new, we must already know

something old. Constructivists and other cognitive psychologists today argue similarly—that in order for new knowledge to be constructed, it must necessarily be built on prior knowledge previously learned as Piaget attempted to explain in the last few years of his life, namely, that knowledge arises from interactions between previous and new cognitive structures (Piaget, 1985).

Giovanni Battista Vico (1668 – 1744)

The Italian philosopher Giambattista Vico remarked that we cannot reconstruct the past exactly as it was because we cannot avoid framing and understanding our recollections without being influenced by the concepts we have at present (Gianturco, 1965). For the current advocates of constructivism, this is an important warning as it points to the fundamental truth that all of our experiences necessarily influence how we construct knowledge. It is with this truth that we are able to conclude, then, that knowledge is particular to the knower, not an independent reality that Western philosophy has subscribed to since the time of Plato. In Vico's initial theory of cognition, *verum ipsum factum* (the true is the made), it is important to note the use of the past participle *factum* of the Latin infinitive "to make," which, according to von Glasersfeld, led him to formulate the epistemological principle that human beings can only know what they themselves have made by constructing elements accessible to them (von Glasersfeld, 1990a). ". . .We have true knowledge when the thinking and the doing are performed by the identical person" noting its "implications. . .for educational theory. That formula…sets up the principle extremely important for pedagogy, of the 'constructive' character of true knowledge" (Gianturco, 1965, p. xxx). For Vico, knowledge not constructed by one's own self is likened to liquid being poured through a funnel into a container: it does not constitute true knowledge.

Rather it is like a gift being received, remaining in our mind like an extraneous, unrelated entity. Instead, Vico indicates, we "gain full understanding of an idea when we achieve a thorough appropriation of it, when we have 'made it ourselves'" (Gianturco, 1965, p. xxx). With this statement, Vico sets the ball in motion for constructivism as a philosophy of learning.

Immanuel Kant (1724 – 1804)

Although he lived his entire life within a 50-mile radius in Germany, Kant was one of the most influential and pivotal thinkers in Western philosophy. In Justus Hartnack's 1974 publication, he describes Kant's theory of knowledge in the following manner:

> We conceive and understand the materials or stuff given to us through our sense organs by applying these categories of understanding. Without being too misleading one may say that the categories are tools by help of which we understand that which is given through the sense organs as the stuff or materials of knowledge (p. 29).

Kant believed that knowledge developed when the mind takes in information about the world from our senses. He writes that experience is constructed by the mind and that the mind has a self-activity in which we determine how we experience the world. For Kant, the truth of the judgment is *a priori* to our experiences. In direct opposition to other philosophical thought, he believed that the mind does not conform to things; rather, things conform to the mind (Tarnas, 1991). Experience is not an image of nature. It is not as if the mind has some kind of neuro-mirror inside it and that through the senses is this mirror of the mind where our self can see and smell and feel and taste what is out there (Goldman, 2006). In his 1798 *Werke,* he writes: "The things our senses and our understanding present to us. . .are the product of the coming together of causal occasions and the effect of understanding" (Kant, as cited in von Glasersfeld, 1990a, p.

40). A few years later, in 1800, Kant publishes a more developed thought in his *vom Erkenntnisvermögen* (The ability to know):

> Perceptions of the senses (empirical presentations with consciousness) can only be internal *appearances*. It is not until the understanding that joins them and connects them by a rule of thought (which brings *order* into the manifold), that they become empirical knowledge, i.e., *experience*. (Kant, as cited in von Glasersfeld, 1990a, p. 40)

This "manifold" Kant is speaking of is the raw material on which constructive perception and reason can operate. Therefore, experience is what the thinking subject constructs out of the elements of this manifold. He points out that things which are constructed (and other things which are not constructed) are determined by our sense's preconscious structure (Goldman, 2006), which "Kant considers the primary topic of his transcendental philosophy. It proposes a painstaking and ingenious model that reason constructs itself. . ." (von Glasersfeld, 1990a, p. 41). From the view of Kant, then, the self-active character of the mind is what constructs experience and is universal, necessary and certain (Goldman, 2006). Finally, because mathematical propositions are based on direct intuitions of spatial relations, they too are *a priori* (constructed by the mind and not derived from experience). Kant holds that mathematics is an example of universal, necessary, and certain knowledge because we constructed it with these preconscious, self-active categories. He was convinced that natural science was scientific to the precise extent that it approximated to the ideal of mathematics (Tarnas, 1991).

Twentieth Century Theorists with Constructivist Overtones

John Dewey (1859 – 1952)

John Dewey set the twentieth-century stage for educational reform as a leader in the

progressive movement of schooling in the United States. Recognized as one of the founders of the philosophical school of pragmatism, he is also known as the father of functional psychology (Boisvert, 1998). For Dewey education depends on action, where the mind is a means for reorganizing and reshaping accepted meanings and values. In his works Dewey frequently repeats to his readers that the mind is an active verb, not a stationary noun (Fosnot, 1996). He stresses the importance of knowledge coming from situations where learners draw them out of experiences that have meaning and importance. These personal situations, he says, necessarily have to occur in a social environment (e.g., a classroom) where students come together to analyze and manipulate material and to create a community of learners who build their knowledge together (Dewey, 1916). According to Dewey, students are not able to learn by rote memorization but only by "direct living," where concrete activities are combined with theory. Dewey's writings indicate that students must necessarily be actively engaged in meaningful activities that bring them to apply the concepts they are trying to learn, thus constructing knowledge.

Lev Vygotsky (1896 – 1934)

Soviet developmental psychologist, Лев Выготский, also contributed considerably to the development of constructivist theories. Along with Jean Piaget, he is considered to be a leader in contemporary developmental psychology (Cole & Wertsch, 2002). Vygotsky's emphasis on children creating in social interaction with others is social constructivist to the core (Vygotsky, 1978). An important facet for his social theory of constructivism is that of "scaffolding," a word coined forty years later by Bruner describing the process of guiding the learner from what is presently known to what is to be known (Vygotsky, 1978; Bodrova & Leong, 2001). Scaffolding

enables students to perform tasks that are slightly beyond their ability without the assistance and guidance from a teacher. Vygotsky formalizes this with his theory of the "Zone of Proximal Development" (ZPD). He notes that when children were tested on tasks by themselves, they rarely did as well as when they were working with an adult—not that the adult was teaching the child how to perform the task, but that the process of engagement enabled them to refine their thinking on their performance to make it more effective (Daniels, 1996). Proper support from the teacher allows students to function on the cutting edge of their individual development. It follows, then, that his theories of scaffolding and ZPD are important characteristics of constructivist learning and teaching. Constructivist theories today insist that teachers play a vital role in students' construction of knowledge. Through this social interaction of students with each other and their teachers, social constructivists posit that each person's respective perception of reality is related; and as they act upon this understanding, their common knowledge of reality becomes reinforced.

Jerome Bruner (b. 1915)

The roots of constructivism can also be traced to the theory of discovery-learning as coined by Bruner in his publication of *The Act of Discovery* in 1961. In this he claims that students must construct their own knowledge through undirected experiences. Discovery-learning, as Bruner discusses, takes place in problem-solving situations where students draw from their own experiences and prior knowledge to discover the truths that are to be learned. Bruner writes,

> Emphasis on discovery-learning has precisely the effect on the learner of leading him to be a constructionist, to organize what he is encountering in a manner not only designed to

> discover regularity and relatedness, but also to avoid the kind of information drift that fails to keep account of the uses to which information might have to be put (Bruner, 1961).

In his 1966 publication, *Toward a Theory of Instruction*, Bruner states that a theory of instruction should address four major aspects: (1) predisposition toward learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishments (Bruner, 1966). The second and third aspects are foundational in classrooms where theories of constructivism are employed in today's classrooms. The teacher's role, then, has shifted from that of lecturer to one where students are encouraged to discover learning by themselves. The teacher and student should engage in active dialogues whereby the teacher translates information to be learned into a format conducive to the learner's state of understanding. Drawing from another important tenet of Bruner's writings, curriculum, then, should be organized in a spiral manner so that the student continually builds upon what they have already learned (Bruner, 1959).

"Acquired knowledge is most useful to a learner, moreover, when it is 'discovered' through the learner's own cognitive efforts, for it is then related to and used in reference to what one has known before" (Bruner, 1996, p. xi-xii). As with most theories on constructivist learning, Bruner also believes that the most thorough learning by students necessarily occurs when they construct their own knowledge in a manner that makes sense to them rather than receiving it by means of presentation in an already organized manner (Zudzina, 1997).

Jean Piaget (1896 – 1980)

Piaget is considered one of the most significant thinkers of child psychology in the twentieth century. And although he was not an educator himself, he has had a more influential role on educational psychology than any other psychologist in history (Jonassen, 1990). In his 1990 publication, D. H. Jonassen refers to Piaget as "one of the better known constructivists in our century." Piaget, however, did not classify himself as a constructivist. His classification as a theorist of constructivism comes about retrospectively from the number of references to him by modern constructivists.

Piaget published his first academic article at the age of eleven in the field of biology. Since then he continued studying the development of living things for decades before turning his attention to the psychological development of humans. With his attention for detail and scientific analysis since childhood, Piaget was primed for groundbreaking work in the development of the human mind. "His approach to developmental psychology was based on an evolutionary epistemology analogizing the development of mind to a biological point of view and, so, highlighting the adaptive function of cognition" (Boudourides, 1998).

For Piaget (1972), the development of human intelligence results from adaptation (a process of assimilation and accommodation) and organization (the structuring of the adapted mental material). He teaches that the organization of the mind is accomplished through a series of increasingly complex and integrated ways. Greatly influenced by Kant, Piaget had a major influence on constructivism (Olssen, 1996). According to Piagetian research, knowledge schemes evolve as a result of progressively more complex interactions with the environment. This interaction results in old schemes evolving into new schemes which result in new knowledge, thus replacing the previously constructed knowledge. Within this model of the

development of juvenile reasoning is represented in terms of an evolution through a series of changes. This is what Piaget characterizes as "adaptation" (Karmiloff-Smith & IInhelder, 1974; McCloskey, 1983; Carey, 1985; Piaget 1963).

Piaget's theory of knowledge can be summarized:

> I think that all structures are constructed and that the fundamental feature is the course of the construction: Nothing is given at the start, except some limiting points on which all the rest is based. The structures are neither given in advance in the human mind or the external world, as we perceive or organize it. (Piaget, 1977, p. 63)

Ever-present in his writings on education are his psychological implications. Piaget writes that teachers should seek to understand the steps in the development of the mind: that the fundamental basis of learning was discovery.

> To understand is to discover, or reconstruct by rediscovery, and such conditions must be complied with even if in the future individuals are to be formed who are capable of production and creativity and not simply repetition. (Piaget, 1972, p. 32)

For children to reach basic understanding of what is being taught, they have to go through stages in which they discover relationships and ideas in classroom situations involving activities of interest to them. Understanding, then, is built up, step-by-step, through active involvement (Piaget, 1973).

The teacher's role in the classroom is central to Piaget's theory of learning. He believes that the teacher is to establish a classroom filled with interesting things to encourage a child to construct his own knowledge and to have the ability to explore (Fosont, 1996). The students must be given the opportunity to construct knowledge through their own experiences in the classroom, not simply absorb knowledge by the impartation of the information from the teacher.

According to Piaget's educational theory, emphasis is not placed on direct instruction but more on learning through "hands-on/minds-on" interaction of the student and his environment. A student who achieves knowledge through free investigation and spontaneous effort will be able to retain that knowledge and will have acquired a methodology that can serve a lifetime. In 1973, he says:

> To understand is to discover. . . A student who achieves a certain knowledge through free investigation and spontaneous effort will later be able to retain it: He will have acquired a methodology that will serve him for the rest of his life, which will stimulate his curiosity without the risk of exhausting it. At the very least, instead of having his memory take priority over his reasoning power. . . He will learn to make his reason function by himself and learn to build his own ideas freely. The goal of intellectual education is not to know how to repeat or retain ready-made truths. It is in learning to master the truth by oneself at the risk of losing a lot of time in going through all the roundabout ways that are inherent in real activity. (p. 106)

From this quote, we see that regarding teaching students how to learn (and how teachers should teach), Piaget's theory agrees with the proverb: "Give a man a fish; you have fed him for today. Teach a man to fish; and you have fed him for a lifetime." In the above quotation when referring to a child "build[ing]" his own knowledge, we see Piaget's cognitive constructivist tendencies shining through.

Ernst von Glasersfeld (b. 1917)

One of the most current prolific developers of constructivism, Ernst von Glasersfeld can be called the Father of Radical Constructivism. Unlike many of the previous theorists discussed,

von Glasersfeld recognizes constructivism as an established theory. Not that he has not added much to the theory from a philosophical and educational standpoint, but he speaks very matter-of-factly about its implications to education rather than as an emerging theory. In *Radical Constructivism* (1995), he says that "Constructivism does not claim to have made earth-shaking inventions in the area of education; it merely claims to pride a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation." In addition to its application to education, von Glasersfeld is pointing out that constructivism has implications beyond the field of education. For him, it is a way of seeing the world in broad enough terms that multiple interpretations can arise and guide our actions (Phillips, 2000b).

As we have seen, for each of the twentieth century theorists with constructivist overtones, there are just as many "types" of constructivism. When asked about the differences in the types, von Glasersfeld says:

> A few years ago when the term *constructivism* became fashionable and was adopted by people who had no intention of changing their epistemological orientation, I introduced the term trivial constructivism. My intent was to distinguish this fashion from the "radical" movement that broke with the tradition of cognitive representation. (von Glasersfeld, 1992a, p. 170)

The radical constructivist position abandons traditional Platonically philosophical position of what is Real according to which Knowledge has to be a representation of reality (existing prior to its experience). Radical constructivism assumes a more relativist position that knowledge is something that is personally constructed by individuals in an active way as they attempt to give meaning to socially accepted and shared notions (1992a). Von Glasersfeld holds that "knowledge is the result of an individual subject's constructive activity, not a commodity

that somehow resides outside the knower and can be conveyed or instilled by diligent perception or linguistic communication" (1990a, p. 37). With this statement on his version of constructivism, von Glasersfeld is not only breaking philosophical and epistemological ties with ancient philosophy, but also with other modern constructivist theorists who held that linguistics were a key to acquisition of knowledge.

> Verbally explaining a problem does not lead to understanding, unless the concepts the listener has associated with the linguistic components of the explanation are compatible with those the explainer has in mind. Hence it is essential that the teacher have an adequate model of the conceptual network within which the student assimilates what he or she is being told. Without such a model as a basis, teaching is likely to remain a hit-or-miss affair. From the constructive perspective, 'learning' is the product of self-organization. (von Glasersfeld, 1989, p. 136)

Similar to other constructivist theorists beginning with Vico, von Glasersfeld holds that learning necessarily has to do with the way that we organize and associate what we are learning with what we've already known. Communication alone, however, is not all that is required for students to acquire knowledge. Essential to constructivism, for von Glasersfeld, is that there is a personal and unique association that is necessary for a student to make between prior knowledge to what he or she is trying to learn. He cites Vico in his 1989 publication:

> One of Vico's basic ideas was that epistemic agents can *know* nothing but the cognitive structures they themselves have put together. He expressed this in many ways, and the most striking is perhaps: "*God is the artificer of Nature, man is the god of artifacts.*" Over and over he stresses that "to know" means "to know how to make". He substantiates this by saying that one knows a thing only when one can tell what

components it consists of. Consequently, God alone can know the *real* world, because He knows how and what He created. In contrast, the human knower can know only what the human knower has constructed. (p. 123)

Evident with his continual references to God as the only True possessor of Knowledge, this treatise is very Platonic in philosophical form but nevertheless hones in on von Glasersfeld's notion of how we come to have knowledge: only when we construct understanding for ourselves can we truly have knowledge and that this knowledge is particular to the knower.

Educational Implications from Constructivism

From the preceding sections on constructivist theorists, it suffices to say that there is a continuum within the realm of constructivism with cognitive on one end and radical on the opposite with social and other developing forms in between. While discussing them in detail is beyond the scope of this chapter, I have tried to touch on several of them when discussing the previous theorists with their particular constructivist bent. "The term constructivism itself covers a panoply of theoretical positions. Some of these appear to be eclectic positions in which researchers attempt to combine the notion of learning as active construction with aspects of the representational view of mind" (Cobb, Yackel, & Wood, 1992, p. 3). In terms of its educational significance, constructivism maintains that knowledge originates as the product of activity or operations on the world (Olssen, 1996). The notion of operations was first used by Vico and then by Piaget, and also has resonance with John Dewey.

Because of its explicit implications, we turn our attention to Ernst von Glasersfeld's radical constructivism and its influence in the epistemological and pedagogical realms of the education reform of mathematics that began a few years prior to the turn of the millennium.

While building on others' theories within the spectrum of constructivism, von Glasersfeld (1987) aims to answer two questions in defining his theory:

1. Under which conditions will a new construct be considered compatible with what has been constructed previously?
2. Why should any organism undertake the task of cognitive construction?

First, he begins with the realization that "knowledge cannot be the result of a passive receiving but originates as the product of active subject's activity" (von Glasersfeld, 1987, p. 206). Secondly, "constructivism allows us to put in relation something that has already been experienced to a second different experience" (von Glasersfeld, 1987, p. 208).

A key differentiation between other forms of constructivism is that radical constructivism posits that there are no universal Truths. Since ancient times philosophers have debated whether or not there exists Truth in some outside realm. Radical constructivists break with traditional philosophy and dismiss the necessity of any existence of universal, ontological form of Knowledge (this position is called realism), citing that personal experience dictates knowledge making it necessarily particular to the knower. Thus, radical constructivism is defined as "a postepistemological perspective" (Orton, 1995, p. 206). Constructivists "deliberately and consequentially avoid saying anything about ontology, let alone making any ontological commitments" (von Glasersfeld, 1985, p. 100, as cited in Kilpatrick, 1987, p. 10). While an external world of Truths may exist, it is unknowable to the individual (von Glasersfeld, 1990a, 1996a). Additionally, since our knowledge is constructed from experience, that which is constructed is not, in any discernable way, an accurate representation of the external world of Truths or reality (von Glasersfeld, 1990a, 1995a).

For radical constructivists, knowledge is not an objective truth but a model of experience

(von Glasersfeld, 1995a). Goldin (1990) says that one major source of our knowledge comes selectively to us via our senses (sense-data). He cites another possible source of knowledge is logical reason and introspection. He says that without any evidence for a form of telepathic perception, individuals are unable to experience events exactly as others do. Thus, he says, no one can ever conclude that one's own knowledge is exactly the same as that of another individual. Thus, he is emphasizing each person's constructs are particular to the knower—even knowledge of mathematics. For constructivists human knowledge is necessarily constructed out of the individual's world of experience, thus the learning necessarily entails a process of construction. Additionally, they maintain that an individual's world of experience is context-dependent—unique to each individual, thus by its very nature, inaccessible to others (Goldin, 1990).

Von Glasersfeld refers to his version of constructivism as radical by claiming that constructivism has to be applied to all levels of description. "Those who. . .do not explicitly give up the notion that our conceptual constructions can or should in some way represent an independent, 'objective' reality, are still caught up in the traditional theory of knowledge" (von Glasersfeld, 1991, 13). Following the skeptical philosophy of Vico's *verum ipsum factum*, von Glasersfeld holds that whichever view of the world we construct, we do not have any means to validate it from some outside, ontological means. Constructivism requires a radical shift that "eliminates the paradoxical conception of truth that requires a forever unattainable ontological test" (von Glasersfeld, 1989, p. 129). In defining this form of constructivism, von Glasersfeld teaches that knowledge is viable only when it stands up to experience and enables us to make predictions and to bring about or to avoid, depending upon the case, certain phenomena (e.g., experiences, events). When knowledge fails to serve that purpose, it becomes questionable,

unreliable, useless and is eventually devalued as superstition (von Glasersfeld, 1987). Said differently, the ideas we derive from the world are constantly undergoing the process of being exposed to the experiential world and they are either affirmed as true reality or discarded. Therefore, our knowledge from these experiences does not provide any clue as to what the objective world could be (von Glasersfeld, 1987). Following this teaching, constructivist theories about education hold that students' minds are not blank slates waiting to be written upon by their teachers. As individuals, students must necessarily construct knowledge particular to them which may or may not be arrived at by the same means as the teacher's means of construction. According to von Glasersfeld, all good teachers know that guidance which they give students "necessarily remains tentative and cannot ever approach determination," since within the realm of constructivism there are always a variety of ways of approaching solutions to problems (von Glasersfeld, 1990b, p. 37).

> Radical constructivism starts from the assumption that knowledge, no matter how it is defined, is in the heads of persons . . . What we make of our experience constitutes the only world we consciously live in . . . But all kinds of experience are essentially subjective, and though I may find reasons to believe that my experience may not be unlike yours, I have no way of knowing that it is the same. (von Glasersfeld, 1995, p. 1)

To recap the preceding paragraphs, what von Glasersfeld says about his coined version of constructivism, is that we construct our knowledge, whether with the aid of others in a social environment or not, particularly and individually. It stands, then, that whatever one has constructed—whether theories or algorithms in mathematics or otherwise—is necessarily different than how any other person has constructed it. And although it may seem that one has constructed knowledge the same as someone else, by definition of radical constructivism and

what the theory holds, it is impossible since we have no way of knowing or verifying someone else's constructs other than our own.

Implications of Constructivism for Mathematics Education

Until recently, education could be described as a process of passing facts from those who had them to those who did not, and pedagogy was the art or science of packaging those facts. Students were taught to perform mathematical operations where the goal was to quickly finish a task quickly and then were assessed based on the correctness of their answers. This form of instruction is labeled "direct instruction" (Good & Grouws, 1978; Petersin, Swing, Stark, & Waas, 1984; Rosenshine, 1976) where one finds a relatively familiar sequence of events in mathematics classrooms: an introductory review, a development portion, a controlled transition to seatwork, and a period of individual seatwork. Jere Confrey (1990) suggests that the following three assumptions underlie direct instruction and are subject to challenge by constructivists:

1. Relatively short products are expected from students, rather than process-oriented answers to questions; homework assignments and test items are accepted as providing adequate assessment of the success of instruction (Confrey, 1990).
2. Teachers, for the most part, can simply execute their plans, routines, checking frequently to see if the students' responses are with desirable bounds, and only revising instruction when those bounds are exceeded (Peters & Clark, 1978; Snow, 1972, as cited in Confrey, 1990).
3. The responsibility for determining if an adequate level of understanding has been reached lies primarily with the teacher (Confrey, 1990).

Until students are given an appetite for depth within the mathematical realm of problem-solving, many students will remain frozen in the day-to-day rote problem solving that limits conceptual understanding of mathematics. Constructivism offers a break from the traditional, outdated mode of teaching mathematics. It may be that students are able to achieve correct answers with the traditional form of mathematical pedagogy, but the lack of an in-depth content understanding is what remains lacking. "Using algorithms that have been furnished and drilled, novices achieve correct performance without relying on the simple understandings that result from the perception of essence (Blais, 1988, p. 625). The near total collapse of performance occurs because shallow knowledge is difficult to retain for the novice. Constructivism makes the distinction between information and knowledge. Information, in the strictest sense, can be given or easily transmitted through telling such that correct performance is achieved. Thus, when the purpose of instruction is to transmit information and to achieve correct performance, explanations suffice. Knowledge, however, cannot be transmitted from the haves to the have-nots. Achieving knowledge means achieving expertise, which comes from thinking and acting independently whereby learners construct for and by themselves (Lochhead, 1985).

Inadequacies resulting from the "traditional" paradigm of teaching mathematics were underscored by the work of psychologists discovering better, more foundation-building methods of teaching children. John Dewey (1933) claimed that the entire purpose of education was to produce reflective thinkers. "We need a curricula which encourages students to say what they think, especially when their thoughts are at variance with what we wish them to be" (Lochhead, 1985, p. 7). The quagmire is how we can, on the one hand, get students to express their ideas but on the other not desert our responsibility to lead them beyond their current constructs. If we continually use close-discussions with an authoritative statement of truth, we quickly stop all

student reflection, where students are wise and lazy enough to know that if they remain silent, the teacher will give them the "correct" answer (Lochhead, 1985).

The field of mathematics education is no longer seen as merely computation resulting in a right or wrong answer. Mathematics is a field in science devoted to problem solving and number relations. Rules and procedures of mathematics have far too long been taught in mathematics classrooms without any explanation of "who cares and why" (Germain-McCarthy, 2001).

With the shift in paradigm, the NCTM began an end to the passive form of mathematical learning where teachers stand at the front of the classroom and give a dry lecture as to how we perform mathematical operations correctly, quickly, and without the use of any calculators. With its promulgation of the *Standards* (1989), the NCTM declared that "in reality, no one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics" (p. 58, underscoring added). "When we teach well, a student has to construct his or her own knowledge. The student constructs knowledge without an infusion of teacher thought" (Blais, 1988, p. 629). With the lack of experience by children mathematicians, teachers are responsible for guiding the students' activity, modeling mathematical behavior, and providing examples that will turn student talk into useful communication about mathematics. When students construct poorly, the teacher's responsibility continues to provide a counter-example that will better direct the student to a more logical construction (Davis & Maher, 1990).

Constructivist theorists stress that an important aspect of allowing students to discover mathematics for themselves is to have the students interested in the problems being solved. Among other methods, teacher must necessarily teach students practical, real-world applications of the problems so that student interest can be stoked to the point of engagement in the problem solving (Dossey, 1992). In today's schools, without a concrete understanding of why the

students should care about working particular types of mathematics problems, teachers might as well be teaching to a puppet. Students will generally exhibit more effort in learning mathematics with concrete, real-world applications (NCTM, 2000).

Connecting to real-world applications, students must be flexible enough to solve varying types of problems. By questioning students on how they have constructed their answers—whether correctly or incorrectly—teachers are providing students with an environment of learning where they are continually being led to critically think about their answers. Through this question-and-answer dialogue of critical thinking between students and each other and between the students and teacher, a more solid foundation of knowledge-building takes place in the mind of the student. Constructivist pedagogues insist that children develop their constructive ability through creative experimentation, development of their ideas, and through adaptation of their own knowledge through interaction with their teachers and fellow classmates (Cobb & Bauersfeld, 1995). The role of a teacher, then, has necessarily shifted from that of a lecturer and imparter of knowledge onto the proverbial *tabula rasa* (blank slate), to that of an interlocutor, a facilitator, and stimulator of student learning by prompting the students with real-world situations for investigation, challenging the students to think independently and with their peers. In tandem with the students in the class but on a higher-level, teachers should help students discover the inadequacies in their thinking (Thompson, 1992). Teachers should give fewer explanations and expect less imitation and memorization in constructivist classrooms (Simon & Shifter, 1991). Thus, school mathematics should be about making sense so that the conceptual understanding that students learn in the classroom can be applied to a variety of circumstances beyond the classroom. Application of an existing schema and the formation of new ones stem from the need to make sense of present problems by fitting them coherently into schemas learned

while solving prior problems (Wheatley, 1991). Constructivist teaching involves activities given to the students with real-world, challenging problems that need to be resolved.

Teachers within the mathematics community agree that the antiquated process of educating children in the field of mathematics—one sated with drill-and-practice advocated by the American psychologist Edward Lee Thorndike in his 1922 publication, *The Psychology of Arithmetic*—is in need of continual reform.

Today, teachers must stress higher-level thinking of "meaningful math" such that answers generally accepted as correct as well as all of the others should be assessed—both formally and informally. When a student says that 2+3=5, teachers should ask the student to explain his or her answer no differently than if the student had said that 2+3=6. For the former, we can hope that the student has added three pieces to two pieces and ended up with five pieces. In the latter, though, did the student just mis-add the two addends, or did s/he multiply the problem for any number of reasons? This is a question that must necessarily be answered through dialogue between the student and teacher so that the teacher can assess the student's thinking and thus be guided to help the student (Germain-McCarthy, 2001).

Teacher Professional Development

Few debate the need for ongoing professional development. This call is repeatedly heard from all levels of education from early childhood to the college level. Professional development is one of the national goals of education (National Education Goals Panel, 2000) and has increased noticeably in mathematics arenas because of is highlighted importance the NCTM's *Principles and Standards for School Mathematics* (2000). "Millions of dollars are being spent by individual teachers, schools and districts, states, federal agencies, foundations, businesses, and

industry in an effort to upgrade the skills and knowledge of teachers" (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003, p. 235). Like their students, teachers must realize their roles as lifelong learners; continuing education will never cease to be imperative to better teaching.

The No Child Left Behind (2000) legislation stipulated that only highly qualified teachers should deliver instruction in the core content areas—English, mathematics, and science—so that students are able to master these content standards. The descriptor "highly qualified" remains vague since teachers vary greatly in areas of experience, expertise, education, skill, and preparation.

The first systemic form of in-service training in the United States was the teacher institutes of the late 1800s which had as their purpose the transmission to teachers of content knowledge and "moral character" (Spring, 1994). Eventually, the institutes changed their focus to training of pedagogical methods. Throughout most of the twentieth century, training remained the cornerstone of professional development (Magestro & Stanford-Blair, 2000).

Even though the need for professional development is obvious to those who study school improvement, useful professional development is not taking place in most schools. Miles (1995) aptly describes the current state of professional development:

> Radically undersourced, brief, not sustained, designed for "one size fits all," imposed rather than owned, lacking any intellectual coherence, treated as a special add-on rather than as part of a natural process, and trapped in the constraints of the bureaucratic system we have come to call "school." In short, it's pedagogically naïve, a demeaning exercise that often leaves its participants more cynical and no more knowledgeable, skilled, or committed than before [the professional development workshop]. (p. vii)

The Importance of Teacher Professional Development

Teachers live, work, and interact with many people each day yet are professionally alone. Teachers are rarely watched by anyone other than their students and as a result are often disgruntled and/or racked with apprehension when a visitor observes his/her classroom. Visits by school administration for more than a few minutes are usually scheduled beforehand. The opportunity for fellow teachers to observe others' teaching is rare. Receiving comments and working with other practitioners in a way that sharpens professional teaching skills is exceptional (Fiszer, 2004).

Professionals achieve a certain level of expertise in his/her given discipline and are required to remain current within the field. Surgeons, attorneys, and auto mechanics must demonstrate themselves as remaining current in their professions. Are methods of ensuring that teachers' pedagogy and content knowledge are current and alive within the professional community typically in place? No (Fiszer, 2004). "Professionally, teachers need to develop the capacity to cope with change, to extend and keep up to date with subject knowledge and to try out new pedagogic skills" (Smith, 1996, p. ix).

Failings of Teacher Professional Development

In contrast to the axiomatic assumption that professional growth is a byproduct of educators' programs, teachers in the United States are finding that opportunities for professional growth are underdeveloped and typically of very little use.

> In the midst of what, to some appears to be a multitude of weak and ill-informed professional development programs, we are still erroneously inclined to believe that teacher development programs automatically translate into expert classroom and teaching

> as soon as staff development sessions end, that we can substitute professional development sessions unrelated to assessment and action research for true teacher development and learning, that age-old contradictions between teachers' needs and wants are inconsequential, that we must uncritically and slavishly accept mediocrity and an astounding hodgepodge of sense and nonsense in professional development, that teachers are incapable of facilitating their own professional growth, and that we are everlastingly stuck on the horns of political-economic-social dilemmas when it comes to financing and implementing teacher development programs. (Blase, 2005, p. ix)

The reality of teacher professional development is that it is frequently taught using methods with no active learning components. Teachers sit and listen to an educational theorist who promotes active, hands-on learning for students but puts little effort into putting what he says to the teachers into practice. Adding hypocrisy and agony, the topics discussed are usually not relevant to day-to-day classroom teaching but rather obsolete. "Teachers deserve better and can have what they need in a relatively inexpensive manner-by being given the time and wherewithal to learn from one another" (Fiszer, 2004, p. x). Lesson Study, a form of teacher professional development discussed in the next section, provides teachers with such opportunities to learn collaboratively from each others' experiences. Learning from each other in this manner provides for teachers the opportunity to enhance their pedagogical skills without the cost of having to hire a "professional teacher trainer" consultant from outside of the school. So not only does Lesson Study provide a low-cost means of professional teacher development, but teachers are also guaranteed that the training they receive is relevant to their particular classroom situation. Fiszer (2004) reminds us that

> Ongoing professional development is necessary. Teachers need to refresh one another with ideas and suggestions that cannot be provided through an agenda item at a staff meeting. Children deserve a professional who can go to colleagues to discuss problems encountered in the classroom (p. x).

Only when professional development is part of the structure and organization of the school can a culture of ongoing professional development be reached. One apparent symptom of the estrangement of teacher professional development programs from the daily work of teachers is the perpetual overload teachers suffer, frequently an overload brought about by superfluous work caused by spurious development or improvement programs (Miller, Moon, & Elko, 2000).

Fullan's (1991) review of research found that professional development efforts fail for the following reasons:

- The widespread use of one-shot workshops, which are ineffective
- Topics that are selected by non-participants
- A lack of follow-up after the introduction of new concepts and practices
- Failure to evaluate programs
- Failure to address individual needs and concerns
- District and multidistrict programs that do not address factors within individual schools
- Absence of a conceptual basis for program planning and implementation.

Positive Reforms in Teacher Professional Development

In the last two decades professional teacher development has undergone significant changes. Professional development workshops in the past typically consisted of brief, single-

topic workshops selected by the schools and districts. With the advent of research in this area beginning in the 1990s, efforts have been made to improve professional development with educational series aimed at increasing the focus, intensity, and continuity needed to change classroom practices and prepare teachers to meet the educational needs of their students (Choy, Chen, & Bugarin, 2006).

Leaders in education must create a paradigm shift in the culture of teacher professional development if teacher learning is indeed a priority. "The implementation of a model incorporating peer observations, dialogue, and feedback enlivens the profession for both new and experienced teachers" (Fiszer, 2004, p. 1). Research suggests that the quality of a teacher is the most important factor of student success (Darling-Hammond, 1998). Evidence supports this noting that poorly performing students increased their performance level by as much as 53% when taught by a highly effective teacher (Haycock, 1998).

According to Fiszer (2004), traditional professional development models fail because newly introduced pedagogies are not always incorporated into teacher practice. An exciting connection between training and practice can be cultivated through a cultural shift away from top-down, dialogue-free sessions toward a continuing model of teacher professional development. "Typical top-down sessions are remedial, quick fixes for weak areas or single sessions without ongoing feedback to the practitioners. They are often based on a deficiency model, in which sessions focus on a single skill or attribute that teachers appear to lack" (Fiszer, 2004, p. 1). Blase (2005) believes that education administrators should replace such ruinous programs with programs designed to ensure that teachers' individual learning needs are met by eliminating useless programs and involve teachers in meaningful and productive professional growth. She continues by advocating a type of teacher professional development whereby

teachers have not only the right but the obligation of collaboratively determining what is lacking in their pedagogical skills needed to improve their teaching ability.

> In this space, dialogue between and among fellow teachers as well as the inner experience of reflective dialogue with oneself is paramount… Now is the point at which we decide whether we love and trust teachers and their students enough to share with them the responsibility for their growth. Now is the point at which we refrain from excluding teachers from participation in their own growth and leaving them to their own devices. (Blase, 2005, p. xi)

Characteristics of Successful Teacher Professional Development

In his book, *Professional Development for School Improvement*, Gordon (2004) reports that even though the focus of various professional development programs varies, they share several common characteristics. He writes that characteristics of successful teacher professional development include strong leadership and support, collaboration, data-based development, program integration, relevant learning activities, and professional development as a way of life (Gordon, 2004). The following is a discussion of each of these characteristics.

Gordon (2004) writes that successful teacher professional development must include strong leadership from a school administrator, a teacher, or a group of teachers. Efforts are made to include teachers in leadership from the beginning so that their leadership role can mature as the group continues to grow. Gordon (2004) continues by writing that teacher leaders create the setting with a tone of support and trust, include motivation and remuneration for participation, and provide sustained moral and material support. Lastly, he writes that teacher leaders function also as role models as active participants in the teacher professional development activities.

During the teacher professional development process, all members involved should be considered equals as they work together on every stage of the program development. All are involved in the program planning and delivery (Gordon, 2004). He continues by suggesting that frequently schools form collaborative cooperatives with other schools, districts, and teacher training universities during professional development programs.

Gordon (2004) writes that effective professional development programs start by collecting and analyzing an array of assessment data. As the programs are developed and put into place, members collect data as a source for continuous professional improvement. Much data are gathered in the teachers' respective classrooms, then shared and collaboratively analyzed by the professional development team. All-inclusive program evaluations are conducted periodically by the team members and/or outside observers and serve as the source for program enhancement. Teachers take part in planning evaluations, gathering and analyzing data from the evaluations, and making necessary program revisions based on the recommendations by the evaluators (Gordon, 2004).

In order for teacher professional development programs to prove successful, integration of the programs into the school culture must occur on several levels (Gordon, 2004). Professional development and improvement goals of the school are integrated; individual, team, school, and district goals are integrated; and new professional development programs are integrated with the existing ones (Gordon, 2004).

Gordon (2004) teaches that in effective teacher professional development programs, most of the learning activities occur within the school environment. Specifically, differentiated learning activities may be held separately in order to address issues that concern a specific group.

Learning activities are experiential and participatory. Generally, the techniques learned can be applied immediately at the school or classroom level (Gordon, 2004).

Although most professional development activities are strictly voluntary, attendance at professional development institutes is exceedingly high. One reason for this high rate of participation is what Gordon (2004) refers to as peer norms of participation—unofficial standards among teachers in an area that oblige them to take part in teacher professional development activities. Teachers in these environments consider continuous professional development to be critical to their growth as professional educators. These teacher believe that continuous, sustained teacher professional development is a necessary way of life for those serious in continuing their pedagogical and content knowledge (Gordon, 2004). One type of professional teacher development that ensures may be considered professional development as a ways of life is the Lesson Study Process.

Cultures Conducive to Improved Teacher Learning Environments

In 2004 Fiszer wrote *How Teachers Learn Best: An Ongoing Professional Development Model*. In one of the chapters in his books, he outlines methods for improving teacher learning environments. He begins by writing that a massive shift from isolated teaching to ongoing, collaborative teacher professional development must occur in the cultures of our schools. Scholars of professional development believe that a shift away from traditional isolation of teaching must be aligned with a specific focus and should incorporate peer observation, consistent feedback, and reflective dialogue in order to best benefit our teachers and students (Fiszer, 2004).

According to Fiszer (2004), there are several components needed when teachers strive for

a collaborative focus: Peer observation, consistent feedback, and reflective dialogue. Teacher professional development is especially improved when colleagues collaborate with one another. Teachers who share a common goal and collective drive are well on their way to work through issues that may arise at a school quicker than those who work more independently or without a shared focus (Fiszer, 2004). Fiszer (2004) continues by suggesting that teachers who share a common dedication to an increase in student achievement unites them in solidarity despite the number of years teaching.

Fiszer (2004) cites peer observation as inspiring much enthusiasm from teachers when compared to reflective dialogue and consistent feedback. He continues by suggesting that several benefits can result from observations conducted by one's peers. He writes that the possibility for additional conversation is stimulated by peer observation since both the observer and the teacher are steeped in the learning process, and that peer observation allows teachers to become more comfortable with observers in the classroom since both the teacher and the observers have the potential for benefitting from the teaching and feedback.

As mentioned earlier in this section, isolation continues to plague the teaching profession. Fiszer (2004) writes that in some environments, teachers can teach in a classroom next door to others and never observe his/her neighbor's teaching. When we remain in an environment where the only observations are conducted for a specific reason once or twice a year by administrators, the sense of violation of personal classroom space will continue to perpetuate itself when the notion of observation is brought to one's mind. By encouraging observations by teacher colleagues rather than by administrators only, teachers will become more comfortable having visitors in their classroom and will begin to embrace dialogue that fosters better teaching from exchanging their pedagogical skills and knowledge with each other (Fiszer, 2004).

Fiszer (2004) writes that continued support and dialogue are two components key to environments committed to increased student achievement. Support from fellow teachers is critical. In addition to their support, he writes that administrators from the school and district level must visit regularly with their teachers and continue the dialogue that is necessary for increasing student learning. Fiszer (2004) says that sustainable teacher professional development is incumbent upon the support given by administrators. Without the provisions necessary for this collaborative dialogue, the professional development efforts will yield fewer results. He continues by saying that time must be set aside for teachers to meet regularly with their peers for collaborative development, observation, and analysis with exchanges for the continued improvement of teacher professional development programs (Fiszer, 2004).

Husby (2005) includes teacher reflection as a key feature for successful teacher professional development as cognitive processing resulting from reflection. A collaborative type of format creates opportunities for professional dialogue and peer support. When implemented together, the teaching skills derived from collaborative professional development work well while developing teachers' content knowledge and pedagogical skills.

Regularly scheduled times for teacher exchange of ideas during the day can provide feedback to teachers and opportunities for reflection. Teachers pooling their content and pedagogical resources are at a distinct advantage over those who are more isolated in their teaching. With teachers continually engaged in reflection of self and peer and entering into dialogue about the reflections, effective teachers' professional development will be sustained as teachers continue to grow with and from the experience of their collaborators (Freppon, 2001).

Fiszer (2004) discusses the great need for reflection and dialogue opportunities to be incorporated into the workday.

> Finding ways to meet increasingly diverse student needs requires regular thought and planning… A school climate conducive to reflection and dialogue enhances drive toward improvement in the area of focus. The tone of seriousness about teaching and improvement underscores the feeling that every staff member is responsible for the collective achievement of the student body. (Fiszer, 2004, p. 47)

Conclusion

The need for continued professional development among teachers goes unquestioned. Identifying sustainable teacher professional development that is effective for the varying needs of individual learners is essential. In the previous sections, I have discussed shortcomings of some teacher professional development programs but I have focused my attention on characteristics and facets of successful teacher professional development. In the next section, I will focus my attention on a form of professional teacher development that meets and exceeds these aforementioned qualities that contribute to effective teacher professional development called Lesson Study.

Lesson Study Research

Since arriving in the United States in the 1990s, there have been several Lesson Study groups around the country that have been successful in implementing Lesson Study in area schools. According to Fernandez (2007), the following universities and centers have Lesson Study Research Groups:

- Mills College Lesson Study Group (directed by Catherine Lewis, Distinguished Research

Scholar),

- Chicago Lesson Study Group (directed by Steven Rogg, Associate Professor at DePaul University),
- Teachers College Lesson Study Research Group (directed by Clea Fernandez, Assistant Professor at Teachers College Columbia University),
- Rider University (directed by Sylvia Bulgar, Associate Professor),
- New Mexico State University (directed by Karin Wilburg, Associate Dean),
- University of New Orleans (directed by Yvelyne Germain-McCarthy, Professor), and
- Global Education Resources (directed by Makoto Yoshida)

Since the 1990s, there have been scant publications on the topic of Lesson Study. After a variety of searches on the topic, the databases returned a total of 54 different peer-reviewed articles. Of those, twenty-four were written on the nature of Lesson Study, eight were reviews of books or articles written about Lesson Study, and two were written to advocate that the Lesson Study Process be adopted in school districts as a form of collaborative teacher professional development based on theory alone. Of the 54 scholarly articles, only four were research-based. They focused on the following:

1. Teacher efficacy and student engagement,
2. Changes and challenges in teaching practices though the introduction of Lesson Study under IMSTEP,
3. Creating a curriculum providing all children high quality education, where Lesson Study was a vehicle for achieving this, and
4. Focusing on fostering collaboration within different segments of an education community.

Since the purpose of these articles do not relate directly to this study, I began looking for other documents dealing with the implantation of the Lesson Study Process in schools. Because of the scarcity of research-based peer-reviewed articles, I searched another set of databases for theses and dissertations relating to Lesson Study. These searches returned 45 articles with the phrase "Lesson Study" in the abstract. The majority of these studies were not research studies on Lesson Study. Instead, it played only an ancillary role. However, three dissertations returned were relevant to this study and are described in the following paragraphs.

The purpose of Sitton's (2006) dissertation was to examine teacher perception of the impact of Lesson Study on their content and instructional knowledge. With a population of 32 elementary school teachers, the study focused on teachers' satisfaction with Lesson Study as a model for teacher professional development in one elementary school. The research questions guiding this study were the following:

1. How does Lesson Study increase teachers' content and instructional knowledge?
2. How satisfied are teachers with Lesson Study as a professional development model?
3. How satisfied are teachers with the various components of Lesson Study?
4. How do teachers view the effectiveness of Lesson Study? (p. 6)

The study concluded that the participants were satisfied with Lesson Study and believed that it was an effective type of teacher professional development. Additionally, Sitton reported that her participants believe that buy-in from administration is critical for initiatives such as these if they are to be successfully implemented and sustained.

The second doctoral dissertation examined the effects of Lesson Study on 13 mathematics teachers and students comprising three Lesson Study groups in an urban school.

The research questions seeking answers for this multiple case study include the following:

1. What effects does Lesson Study have on middle school mathematics teachers?
2. What effects does Lesson Study have on middle school students?
3. Does the participation in Lesson Study as a form of professional development serve as a catalyst for growth and continuation of lesson study within the middle school mathematics community?

Meyer (2006) reported that qualitative data revealed that the Lesson Study Process impacted teachers' pedagogical strategies in several different areas. Additionally, she found that in two of the three case studies, teacher content knowledge increased as a result of the collaborative nature inherent in Lesson Study. She noted that although there was strong evidence to support that Lesson Study positively impacted student engagement, complete assurance positively affecting student achievement directly resulting from Lesson Study should be cautioned.

Lastly, Mitcheltree's (2006) dissertation explored how the Lesson Study Process impacted teacher content and pedagogical knowledge at a rural high school. The thrust of her study was to determine whether or not the Lesson Study Process influenced teacher mathematical content and pedagogical knowledge. The study's research participants included four secondary mathematics teachers during the 2004-05 academic year, where they developed three Research Lessons. The research question guiding this study is "How does lesson study influence teacher knowledge and classroom practices?" (p. 6).

Mitcheltree (2006) reported that her research concludes that during the Lesson Study Process teachers' content and pedagogical knowledge are increasing. Lastly, her results indicate that planning and reflecting within the Lesson Study framework play important roles in

increasing teachers' content and pedagogical knowledge.

In addition to the dissertations and scholarly published articles on Lesson Study, Jenny Lott (2006), an undergraduate honors student from the University of New Orleans, wrote her honors thesis on Lesson Study. Her study aided in the conceptualization of this current study. The purpose of her study was to measure the effectiveness of the Lesson Study Process as a form of teacher professional development by exploring responses to the following questions:

1. What are teachers' perceptions of the effectiveness of the Lesson Study Process in improving teaching?
2. What are teachers' perceptions of the effectiveness of the Lesson Study Process in improving student learning?
3. How do teachers' perceptions of the Lesson Study Process correspond to the five Louisiana Components of Effective Teaching (LCET) domains?

Lott's (2006) study concluded that teachers participating in her study indicated that Lesson Study is effective in improving their teaching. She found that the research participants reported that Lesson Study is a good tool for professional development, that teachers plan more effectively than usually while participating in Lesson Study, that the Lesson Study Process makes teachers feel more comfortable teaching, and that participating in the Lesson Study Process improves teachers' ability to teach mathematics. Regarding student achievement, Lott (2006) concluded that the teachers think that their participating in Lesson Study improves students' understanding of mathematics concepts and will improve scores on standardized tests. In summary, Lott's (2006) study concludes that participating in the Lesson Study Process increases teachers' effectiveness in teaching and their students' achievement.

Chapter Summary

Lesson Study seeks to help facilitate an increase of teacher mathematical content and pedagogical knowledge through collaboration. Key to Lesson Study is its constructivist underpinnings. As teachers meet together in each stage of the Lesson Study Process, their attention is drawn to what students know and how they can arrange an environment conducive to students constructing new knowledge built upon their previously learned knowledge. Social forms of constructivism are employed as student constructing new knowledge is a result of their interaction with their peers as well as with the teachers. Scaffolding from schema to connect to new knowledge is key to constructivism and Lesson Study. In the beginning phases of Research Lesson development, teachers work together to identify how the new lesson fits into the spiral curriculum of students' education—how this lesson relates to units in prior, current, and later grade levels.

Heralded by NCTM (2008) as an integral form of professional development for mathematics teachers, Lesson Study could pave the way for a new direction in the growth of student-centered pedagogical skills and an increase in teachers' mathematics content knowledge (Watanabe, 2003; Wang-Iverson, 2002, Yoshida, 2002; Lewis, 2000). As Lesson Study continues to grow in popularity among mathematics educators as a sustainable form of collaborative professional development drawing from an internal knowledge and experience base, and as school and district administrators give increased support to schools and teachers working with Lesson Study, a positive transformation can take place as teachers begin working together to develop student-centered lesson plans leading to a more conceptual understanding of mathematics by students (Post & Varoz, 2008). This study investigates teachers' perspectives of the Lesson Study Process on their teaching and students' achievement as their teaching paradigm

shifts from working alone to a more effective way of planning lessons, teaching, and assessing student achievement by working with other Lesson Study teachers. The positive perspectives of the teachers on the effectiveness of Lesson Study discussed in chapter four advocates for a more wide-spread participation of teachers in our country in Lesson Study.

CHAPTER THREE

METHODOLOGY AND PROCEDURES

> Mixed methods research has come of age. To include only quantitative and qualitative methods falls short of the major approaches being used today in the social and human sciences. (Creswell, 2003, p. 4)

Introduction

The purpose of this study is to investigate whether teachers participating in Lesson Study believe that it is affecting their mathematics content knowledge, pedagogy, and student achievement. In this chapter, I describe the design, the research questions, and the instrumentation used in soliciting answers to the research questions. Next, I describe the participants, the methods for selecting the participants, the procedures used for obtaining responses to the questions posed in the research instruments, and the methods of data collection. Then I discuss limitations, delimitations, and bias monitoring associated with this study. Lastly, I include the data analysis procedures, internal validity, external validity, and reliability. The chapter concludes with a chapter summary where the sections of the chapter are recapitulated.

Design

According to Creswell (2008), the first mixed-methods study was used by Campbell and Fiske in 1959 to study validity of psychological traits. This seminal study prompted others in subsequent studies to employ both qualitative and quantitative means of data collection to best answer research questions when appropriate. Rossman and Wilson (1985) advocate the use of all approaches available to best understand the research problem rather than being bounded by the traditionally mutually exclusive quantitative or qualitative means.

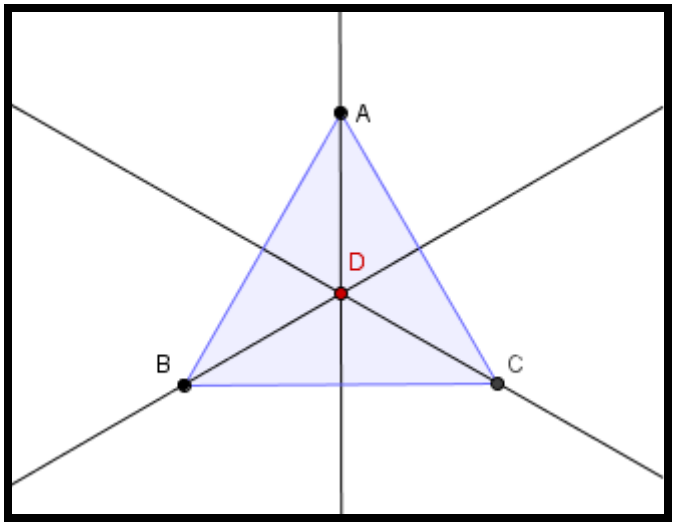
Creswell (2003) states that concurrent design strategies occur when the researcher collects both forms of data concurrently and then "integrates the information in the interpretation of the overall results" (p. 16). The quasi-mixed-method, concurrent triangulation design used in this study employs both qualitative (primary) and quantitative (secondary) means of data collection and analysis to best answer the questions in this study. Within the QUAL-quan framework, a case study strategy of inquiry will be followed to explore in depth the qualitative questions presented by the instruments. Stake (1995) describes case study as an in-depth exploration into a process, a program, or an event of one or more participants where the case is bound by time and activity. He further explains that the researcher should use a variety of data collection procedures over a certain period of time. The case being studied here is bounded by the Lesson Study Process which spans two sequential, one-year Lesson Study cycles.

Understanding that all methods of inquiry have limitations inherent to their nature, many researchers believe that biases in any single method could neutralize or cancel biases found in other methods (Creswell, 2003). Thus, a specific type of triangulating data sources was born, seeking to converge across qualitative and quantitative sources (Jick, 1979). New uses of the term triangulation grew out of this initial reasoning for mixing different types of data. Greene, Caracelli, and Graham (1989) believe that the results from one method can be used to inform another method. In this study, I have employed concurrent procedures where I use qualitative and quantitative data to provide a comprehensive analysis of the research problem.

The following diagram illustrates this concurrent triangulation design. The basis of my design is the equilateral triangle which is constructed using three sides of equal length. The vertices of the triangle represent the three methods of data inquiry used in this study—focus groups (point A), surveys (point B), and questionnaires (point C). The shape chosen represents

the equal footing that the three instruments possess in answering the research questions. Inherent in the formation of an equilateral triangle is its equiangular property in Euclidean space. The centroid is the point formed by the intersection of three angle bisectors. For this study it represents the richest, most comprehensive answer to the research questions posed in this study (point D).

Figure 2: Visual Representation of Concurrent Triangulation Design



Research Questions

The research questions guiding this study are the following:

1. What are the perspectives of teachers on the impact of the Lesson Study Process on their mathematical content knowledge?
2. What are the perspectives of teachers on the impact of the Lesson Study Process on their pedagogical knowledge?
3. What are the perspectives of teachers on the potential impact of the Lesson Study Process on their students' achievement?

Instrumentation

This study employs three methods for collecting data related to the research questions. The first method for collecting data takes place within the context of focus group sessions, the second is a survey, and the third is a questionnaire.

Description of Participants

The teachers participating in this study were part of two one-year teacher professional development institutes focusing on Lesson Study in mathematics education. The first institute took place between June and May of 2007-2008; the second took place between July and May of 2008-2009. Each year the teacher professional development sessions were held for two weeks during the summer, three Saturdays during the fall semester, three Saturdays during the spring semester, and support observations.

Eighty-three percent of the teachers were certified to teach in this state—either through a traditional four-year education program leading to a baccalaureate degree in education or through a post-baccalaureate, alternate certification program. Those not possessing certification were employed by non-public education institutions and were not required to be certified by the standards set forth by the state public education system. Participants included both male and female representing an ethnic cross-section representative of a southern metropolitan area. A comprehensive view of the participating teachers' demographics can be found in Table 3.

This paragraph describes the two-year group of teachers participating in the institute from 2007-08 and 2008-09. The study was comprised of 51 females (92.73%) and 4 males (7.27%) for a total of 55 participants. Of the females and males in the study, 29 (52.73%) identified themselves as being European-American, 25 (45.45%) identified themselves as being African-

American, and 1 (1.82%) identified as Other (neither American Indian, Alaskan Native, Hispanic, African American, Asian/Pacific Islander, nor White). Thirty-eight (69.09%) of the participants had a baccalaureate degree only, sixteen (29.09%) had a baccalaureate degree and a masters degree, and one (1.82%) had only a high school diploma. The teachers have been teaching an average (arithmetic mean) of 10.6604 years, with the median number of years being nine. Table 2 lists the number of teachers in the study by school district.

Table 2: Number of Teachers in the Study by School District.

District Identifying No.	Number of Teachers
1	9
2	10
3	3
4	3
5	10
6	6
7	8
8	2
9	4

Table 3 lists the demographic data of the participants broken down by academic year, concluding with totals of all of the participants.

Table 3: Demographics of Participants

	Year 1: 2007-08	**Year 2: 2008-09**	**Total**
Total Participants	29	26	55
Gender-identity:			
Female	28 (96.55%)	23 (88.46%)	51 (92.73%)
Male	1 (3.45%)	3 (11.54%)	4 (7.27%)
Racial-identity:			
African American	11 (37.93%)	11 (42.31%)	25 (45.45%)
European American	18 (62.07%)	14 (53.85%)	29 (52.73%)
Other[1]	0 (0%)	1 (3.85%)	1 (1.82%)
Education[2]:			
High School diploma	0 (0%)	1 (3.85%	1 (1.82%)
Baccalaureate degree	22 (75.86%)	16 (61.54%)	38 (69.09%)
Masters degree	7 (24.14%)	9 (34.62%)	16 (29.09%)
Experience, in years:			
Mean	11.93	9.24	10.66
Median	11	6	9
Minimum	1	1	1
Maximum	32	34	34
Standard Deviation	8.96	8.75	8.88
Type of School:			
Private	0 (0%)	6 (23.08%)	6 (10.91%)
Public	29 (100%)	20 (76.92%)	49 (89.09%)

Participant Selection

Each teacher participating in the Lesson Study workshop was invited to participate in the study. Of the total number of teachers in the institutes, there were eleven who volunteered to participate in the focus group of 2007, nine in the first focus group session of 2008, and nine volunteered to participate in the second focus group of 2008. Of the teachers in 2007, 17 of 25 (68%) chose to participate in the survey; 25 participated in the questionnaire. In 2008, 26 teachers chose to participate in the survey and 13 completed a questionnaire. Table 4 summarizes the participant participation categorized by research instrument.

[1] Neither American Indian, Alaskan Native, Hispanic, African American, Asian/Pacific Islander, nor European American.

[2] Highest Level Completed

Table 4: Number of Participants per Research Instrument

Research Instrument	**Year 1: 2007-08**	**Year 2: 2008-09**	**Total**
Focus Group A	$n_1 = 11$	$n_{2A} = 9$	$n_1 + n_{2A} = 20$
Focus Group B	*n/a*	$n_{2B} = 9$	$n_1 + n_{2B} = 9$
Survey	$n_1 = 17$	$n_2 = 20$	$n_1 + n_2 = 37$
Questionnaire	$n_1 = 25$	$n_2 = 13$	$n_1 + n_2 = 38$

Procedures

The study is limited to teachers participating in a professional development grant where the focus was to increase teacher mathematics content and pedagogical knowledge. One aspect of this professional development is Lesson Study. The grant project director, who has worked with Lesson Study since 1998, instructed the teachers on Lesson Study theory and application for implementation in their classrooms. During the summer institutes, the teachers formed teams grouped by the schools and began developing the Research Lessons. Once returning to their respective schools in the fall, they began implementing the process in their classrooms by working with other Lesson Study teachers in the development and teaching of two Research Lessons per academic year.

Year 1: 2007-08

The teachers met for twelve days during the summer to learn new pedagogical skills for teaching mathematics, integrating literacy into their planning, and enhancing their mathematics content knowledge. Each day of the institute was segmented into two parts: the first half was devoted to the content mentioned in the previous sentence; the second half of the day was devoted to implementing the content in the classrooms through the Lesson Study Process. After learning about the Lesson Study Process during the summer institute, the teachers began developing preliminary plans for developing the Research Lessons—looking at student data for

developing their goals, outlining their grade level expectations (GLEs) within the spiral curriculum, and writing the lessons specific to their grade levels. At the end of the summer institute, eleven of the teachers volunteered to participate in a 30-minute focus group session held during their lunch hour of the final day of the institute. During this time, the teachers were able to discuss with me and their colleagues what they felt the potential effects of Lesson Study would be on their teaching and their students' achievement. During one of the Saturday workshops held at the university, the teachers were asked to complete the survey. Lastly, at one of the final Saturday workshops of the academic year, the teachers were asked to complete the questionnaire. For those not present at the Saturday workshops, a link to the survey and/or questionnaire was emailed to the teachers for their completion at www.surveymonkey.com.

Year 2: 2008-09

The teachers met for ten days during the summer to learn new pedagogical skills for teaching mathematics, integrating literacy into their planning, and enhancing their mathematics content knowledge. Each day of the institute was segmented into two parts: the first half was devoted to the content mentioned in the previous sentence; the second half of the day was devoted to implementing the content in the classrooms through the Lesson Study Process. In the same manner as the first year, the institute participants were asked to participate in the focus group session on the last day of the summer institute. Nine teachers agreed to participate. On one of the Saturday workshops, the teachers present were asked to complete the survey. After an initial analysis of the previous and current year's data, the doctoral faculty members advising this study recommended that an additional focus group session be held in an attempt to solicit a wider variety of answers from the teachers. Per their guidance, I developed a new set of questions and

held the focus group session during the last Saturday workshop of the fall semester. Finally the teachers were asked to complete the questionnaire during the first Saturday workshop of the spring semester. As with the first year, those unable to complete the survey and/or questionnaire in person were given the opportunity to complete one or both of them online.

Methods of Data Collection

This study will use focus group sessions, a survey, and a questionnaire for collecting data. The questions in the present survey were adapted from a previous survey developed by the grant's project director and one of her honor students during a Lesson Study cycle in 2006. Where necessary the questions have been updated to better fit the research questions pertinent to this study. The responses yielded from that study helped shape the guiding questions in the focus group session in 2007 and in the first focus group session of 2008. Based on the information received from the focus group session of 2007, I further modified the survey questions to better answer the research questions in this study. In addition to the data collected in 2006, the focus group sessions yielded emerging themes which were used when designing the questionnaire. Although the focus groups yield richer, more in-depth data, the survey and questionnaire were convenient means of collecting data from a larger group of participants. The close-ended questions allowed for a means of quantitative analysis of the Likert ratings. Upon an analysis of the data from the first two focus group sessions, the surveys, and the first year's questionnaires, an additional set of focus group guiding questions were developed to understand more fully teachers' perspectives of Lesson Study. A copy of the survey and questionnaire are located in the appendix.

During both summer institutes, the teachers learned the theory behind Lesson Study and how it is implemented in a school. By the end of the summer, they began working on their Lesson Study team's Research Lesson at which time the first survey was administered. In summary, the data collected from the teachers during the summer were based more on theory than practice since the teachers were not yet in the classroom environment.

Focus Group Sessions

The focus group sessions were designed to gain a richer understanding of teachers' perspectives on the Lesson Study Process. Focus groups involve the "explicit use of group interaction to produce data and insights that would be less accessible without the interaction found in a group" (Morgan, 1988, p. 12). During those sessions the teachers answered the questions while being encouraged and motivated by the answers of the other teachers. The researcher of this study served as moderator of the focus group to ensure that the sessions remained on target and also to pose guiding questions that would help guide the teachers in the interest of the study. The focus group sessions were videotaped and transcribed for accuracy in data analysis. The following questions were used to guide the first and second focus group discussion.

Table 5: Focus Group A Guiding Questions

1. Using the Lesson Study Process, is your content knowledge of mathematics changing?
2. How is it changing?
3. Using the Lesson Study Process, are your pedagogical skills changing?
4. How is it changing?

Table 5, continued

5. Are there any issues/problems that you foresee with the Lesson Study Process as you try it in your school?
6. What are some ideas for overcoming some of the issues/problems?
7. What are your thoughts about how Lesson Study in your school might improve the teaching of difficult lessons?
8. Did you find the workshop valuable so far? Why?
9. What are some suggestions for improving this workshop?
10. Do you feel that Lesson Study can affect student learning? How?

I conducted the first focus group session after having read about their nature, how to conduct one, and how they fit into qualitative research. After courses on qualitative research—including sections of the semester devoted to conducting focus group sessions—I realized that my techniques needed improvement. Specifically, from reading the data from the first focus group session, I discovered responses from the teachers that should have been probed for clarity and richer understanding. Additionally, learning how to structure questions in more sophisticated, non-leading dialogue is critical—rather than a more rigid question-answer style that generally proves fruitless and, in many ways, defeats the purpose of conducting focus groups.

Therefore, in an attempt to better understand what the teachers' perspectives of what Lesson Study is, an additional focus group session was planned with new guiding questions. Understanding how teachers describe the Lesson Study process to readers is valuable in framing the context in which the teachers have answered some of the questions in the other instruments.

With that in mind, new questions were developed aimed at examining the teachers' negative and positive views of the effects of the Lesson Study Process on their teaching and students' achievement.

Spradley (1979) advocates using *grand tour questions* when preparing for focus group sessions. As the name suggests, these questions ask participants to provide a spoken tour of some event, process, or procedure with which they are very familiar. Using Spradley's (1979) model for developing grand tour questions, the following questions were used to guide the third focus group discussion:

Table 6: Projected Focus Group B Guiding Questions

1.	I know each of you has done a lot of thinking about Lesson Study over the past several months and working with your colleagues on developing a Research Lesson for your students. I'd like for you to describe what Lesson Study means to you as if you were describing it to someone who didn't know what it was.
2.	How have you experienced the process of Lesson Study with peers and your students?
3.	You talked a moment ago about the some of the aspects or steps involved in the Lesson Study Process. Tell me about a specific negative and positive experience you've had based on what you just described. If needed, 3b. Ok, you've told me about several <positive/negative> experiences, can you talk a little bit about any <negative/positive> experiences you've had during the Lesson Study Process? What was the key aspect of this experience that made it positive/negative for you?

Table 6, continued

4.	One of the steps in the Lesson Study Process you just described for me was the collaboration that goes on between you and your colleagues. I'd like for you to describe what goes on during your Research Lesson collaboration meetings.
5.	You've been collaborating with other teachers on the development of your Research Lessons for almost five months now. During this time you've perhaps discovered new ways of understanding the math content. What new understanding of math content has developed as you've been working with the Lesson Study Process?
6.	What new methods of teaching have you developed from working within the Lesson Study framework?
7.	Now tell me about a positive and negative experience you had while planning a Research Lesson with other teachers. If needed, 7b. Ok, you've told me about several <positive/negative> experiences, can you talk a little bit about any <negative/positive> experiences you've had while planning Research Lessons with other teachers?
8.	How do you feel Lesson Study has affected student achievement?

As mentioned in Chapter Two, focus group sessions epitomize social constructivism from a Vygotskian point of view. The crux of employing focus groups as a means of gathering rich data is their social design with verbal interaction among the teachers. Various theorists believe that language has an indispensable role in learning. Vygotsky describes language as the logical and analytical thinking tool and that thoughts are not merely expressed through the words but are created through the words (Vygotsky, 1962). Through thoughtful reflection on the

questions being posed and answers given by the other focus group members, the participating teachers construct their own idea of how Lesson Study can affect their teaching and thus student achievement.

Survey

The survey contains eighteen close-ended questions and five open-ended questions. The first section polls the teachers' demographics using five questions. The following questions are asked in the first section.

Table 7: Survey Demographic Questions

1. In what school district do you currently teach?
2. What grade level do you currently teach?
3. How many months have you participated in Lesson Study?
4. How many years have you taught prior to this school year?
5. What is your educational background?

The second section asks the participants to circle the choice that best describes their personal opinion regarding the statements. The responses to the ten statements were designed using a four-point Likert scale with the following choice of responses: Strongly Agree, Agree, Disagree, and Strongly Disagree. The participants are asked to circle the response that best describes their personal opinion regarding the following statements.

Table 8: Survey Close-Ended Questions (4-point Likert Scale)

1. Teachers plan lessons more effectively than usual while participating in Lesson Study.
2. The Lesson Study Process is a good tool for teacher professional development.
3. I plan to continue using Lesson Study in the future.
4. I think Lesson Study has positively impacted students' understanding of math concepts.
5. I think practicing Lesson Study has positively impacted students' scores on standardized tests.
6. I feel more comfortable teaching lessons with observers in the classroom as a result of the Lesson Study Process.
7. The Lesson Study Process makes me feel more comfortable teaching math.
8. Participating in the Lesson Study Process has improved my knowledge of math content.
9. Participating in the Lesson Study Process has improved my ability to teach math.
10. After teaching a lesson developed by the team, I find the observers' comments and the reflection/revision process helpful.

The third section asks five open-ended questions soliciting information on their perspectives on the Lesson Study Process. Typical to these scales, the participant is instructed that 10 is the highest possible rating and 1 is the lowest possible rating. The questions in this section are located in the following table.

Table 9: Survey Open-Ended Questions

1. What do you think are the advantages of the Lesson Study Process?
2. What do you think are disadvantages of the Lesson Study Process?
3. How do you think Lesson Study has affected student learning/achievement?
4. How do you think Lesson Study has affected your learning of math?
5. Other Comments:

The final section employs a ten-point Likert scale asking the participants to rate their overall perspectives on Lesson Study improving their teaching of math (pedagogy), math content knowledge, and student achievement. The following statements appear in the final section of the survey.

Table 10: Survey Close-Ended Questions (10-point Likert Scale)

1. Please rate your overall perspectives of Lesson Study on improving your teaching of math (circle):
2. Please rate your overall perspectives of Lesson Study on improving your math content knowledge (circle):
3. Please rate your overall perspectives of Lesson Study on improving student achievement (circle):

Questionnaire

The final instrument, a questionnaire, contains eight open-ended, questions. The reasoning behind using this instrument is twofold: (1) It may confirm that the teachers'

perspectives on the effectiveness of Lesson Study has continued to grow since putting it into practice during the two semesters, and (2) it gives access to a richer, more expressive means of answering the questions relating to Lesson Study's effectiveness than with close-ended questions. As compared to the focus groups, the questionnaire seeks to collect data on how Lesson Study's effectiveness is perceived by the teacher after s/he has been working with it for several months in his/her classroom. The following questions are used for the questionnaire.

Table 11: Questionnaire Questions

1. Using the Lesson Study Process, is your content knowledge changing?
2. If so, how is it changing?
3. Using the Lesson Study Process, are your pedagogical skills changing?
4. If so, how are they changing?
5. Are there any issues/problems that you foresee with the Lesson Study Process as you try it in your school?
6. What are some ideas for overcoming some of the issues/problems, if any?
7. What are your thoughts about how Lesson Study in your school might improve the <u>teaching</u> of difficult lessons, if any?
8. What are your thoughts about how Lesson Study in your school might improve the <u>learning</u> of difficult lessons, if any?

Limitations

Due to time constraints and logistical restrictions, this study focused on only two sets of teachers in a metropolitan area participating in a year-long Lesson Study professional

development program. These participants may not be representative of Lesson Study teachers across the nation or worldwide. Therefore it is too bold to claim that the conclusions found in this study apply to Lesson Study teachers and students in general.

Bias Monitoring

One's bias, according to Peshkin (1988), "is like a garment [that] cannot be removed" (p. 17). It is insistently present during all aspect of our lives—while conducting research and otherwise. In an attempt to temper out as much bias from the study as I could, I worded the questions on the survey in a neutral manner, thus inviting the reader to respond honestly without being influenced by any particular perspective. For example, rather than asking the teachers about the perceived benefits of Lesson Study, I asked them about their perspectives on the effects—soliciting both positive and negative responses. I also included separate questions asking about the teachers' perspectives on the disadvantages and advantages of the Lesson Study Process. Finally, Focus Group B was designed such that if only positive or negative responses were given by the teachers, the researcher could immediately follow-up with an additional question to uncover any responses contrary to the responses given in the previous question.

The questions used in each of the instruments were also developed in an attempt to be as bias-free as possible. Although some of the survey questions are results of a previous study, I modified them to better seek answers to my research questions after those were determined. I developed all of the other questions under the supervision of some of my dissertation committee members so that they could offer their advice and experience in preventing as much bias from seeping into the wording of the questions. As mentioned earlier, Focus Group B was developed to get a better view of the teachers' perspectives on Lesson Study but also provide a more neutral wording of the questions than Focus Group A.

Creswell (2008) refers to several means of validating the accuracy of analyzing data. He refers to *member checking* as "a process in which the researcher asks one or more participants in the study to check the accuracy of the account" (p. 267). I asked two participants to review the data and analysis, once it has been completed, to verify that the findings that I have reported match the sentiments of the data. Creswell (2008) also suggests selecting an outsider to the study to review the analysis and report back the weaknesses and strengths found in the analysis. He refers to this as an *external audit*. I asked two doctoral students uninvolved with this study to provide me with feedback on the strengths and weaknesses found in the analysis that I have conducted on the data in my study. Throughout the research process I remained vigilant not to allow my personal involvement with Lesson Study to distort any consideration of the participants' experience.

Autobiographical Disclosure

During the semester I completed my master's degree I began looking into pursuing a doctoral degree in mathematics education. At the end of my first meeting with one of the doctoral advisors on the possibility of my pursuing a post-graduate degree, I was offered a research assistant position on the Lesson Study grant. One of the drawing points of working on the grant was to investigate the positive effects that Lesson Study has on education. I also learned that by working daily with the principle investigators on the grant, the teachers, and the relevant literature, I would uncover several avenues that I could explore for my dissertation. From the beginning of my exposure to Lesson Study I began learning of its benefits to teachers and their students. As an advocate of the Lesson Study Process, I recognize the bias I have when approaching the research questions, the instruments, and the participants in this study.

After narrowing down my area of interest and research questions I decided that employing a mixed methods triangulation in this study would be one effective means of ensuring the validity my analysis of the data. By using both close- and open-ended questions in my instruments, I would be able to analyze the collected responses from both a quantitative and qualitative means. Once these analyses were complete, the quantitative and quantitative data would either converge or diverge. If it diverged, an analysis of the cause of its divergence would pave the way for future studies. In summary, while I recognize that my lens for viewing the research questions, participants, and data in this study is not free of bias, I have disclosed it as thoroughly as possible and have included several means for ensuring the presentation of the results in this study as free of bias as possible.

Data Analysis Procedures

In the interest of data analysis, the statements and questions used in the data collection instruments were divided into two categories: teaching and student achievement. Before I began analyzing the data, I segregated the questions on the survey, the questionnaire, and from the focus group sessions by the research questions they related to. Then I asked two doctoral faculty members on my committee and another doctoral candidate in mathematics education to do the same. Any disagreements we had were discussed and a consensus was reached.

Because of the small sample size—which I have discussed more thoroughly in Chapter Four—the only statistical analysis I was able to run on the quantitative data was related to the central tendency attributes. In chapter four, I present a mean score and standard deviation for each of the survey's close-ended questions segregated by research question. A grand mean was calculated in order to show that the teachers indicated that they did believe that teaching and

student achievement were positively affected by their participation in the Lesson Study Process. The grand means allowed me to rank the teachers' perspectives on the effectiveness Lesson Study had on teaching and student achievement.

Once the instruments' questions were segregated by research questions, I read through the qualitative data several times before making any assumptions about categorization. As I noted key words emerging throughout the participants' responses, I began to think in terms of categorizing the data by those words. I labeled the data with the categories and again asked a doctoral candidate in mathematics education to do the same. We then discussed any discrepancies between our two categorization systems before determining a final system. The Qualitative Findings section in Chapter Four recapitulates these procedures and includes citations from qualitative researchers as to the authenticity of these methods.

Internal Validity

The guiding questions used during the focus group sessions, the survey questions, and the questionnaire questions used in this study were designed to assess teachers' perspectives on the Lesson Study Process as they focus on the main components of Lesson Study discussed in chapter two: collaboration, teaching, and learning. All three data-gathering instruments contributed to understanding teachers' perspectives on these three components. Each of the questions about Lesson Study necessarily focused on collaboration as it is inherent to the Lesson Study Process. The following table lists each of the research questions and correlates which question on each of the instruments seeks to answer that specific research question. The correlation was done separately by my major professor and me. Any disagreements between research and instrument questions were discussed and agreed upon.

Table 12: Correlation of Research Question #1 and the Research Instruments' Questions

Research Question #1: What are the perspectives of teachers on the impact of Lesson Study on their mathematical content knowledge?	
Instrument	**Question Number**
Focus Group A Guiding Question Numbers	1, 2
Focus Group B Guiding Question Numbers	5
Survey Question Numbers	2, 7, 8, 9, 17; 11, 14
Questionnaire Question Numbers	1, 2

Table 13: Correlation of Research Question #2 and the Research Instruments' Questions

Research Question #2: What are the perspectives of teachers on the impact of Lesson Study on their mathematical pedagogical knowledge?	
Instrument	**Question Number**
Focus Group A Guiding Question Numbers	3, 4, 7
Focus Group B Guiding Question Numbers	1, 4, 6
Survey Question Numbers	1, 2, 3, 6, 9, 10, 16; 11
Questionnaire Question Numbers	3, 4, 7

Table 14: Correlation of Research Question #3 and the Research Instruments' Questions

Research Question #3: What are the perspectives of teachers on the impact of Lesson Study on their students' achievement?	
Instrument	**Question Number**
Focus Group A Guiding Question Numbers	10
Focus Group B Guiding Question Numbers	8
Survey Question Numbers	4, 5, 18; 13
Questionnaire Question Numbers	8

Can we be certain, however, that the questions in the research instruments are truly asking what I intended them to ask; that is, do they have internal validity? Conclusions based on data are said to contain internal validity if there exists a properly demonstrated causal relationship between two variables (Brewer, 2000). This study intends to measure teachers' perspectives of Lesson Study on their teaching and student achievement. I will be using factor analysis (FA) to determine whether or not the research questions correlate with what I intended them to ask. Specifically the variables—the research question topics—will be clustered into

groups (factors). Vogt (2007) writes that factor analysis is a reliable method of exploring patterns among any set of correlated data. He adds that "factor analysis could tell you whether and how the items cluster together by showing which questions were answered in the same ways by respondents. The items *within* each group (factor) would correlate highly with one another" (p. 230, emphasis in original). "The factors identified, not the many individual items within the factors, are then used as variables. Factor analysis produces a manageable number of factor variables to deal with and analyze" (Gay, Mills, & Airsasian, 2006, p. 204). Since the researcher has developed the instruments' questions in an attempt to best answer the research questions, this study will use a specific type of FA called confirmatory factor analysis to determine whether or not the hypothesized structure fits the data.

The open-ended questions will be validated using face validity which measures the degrees to which a test properly "looks like" it measures that which it intends to (Banks, 2005). Since this study intends to measure whether teachers' perspectives reflect that Lesson Study affects their teaching and student achievement, and the responses from the participants in this study indicated that the questions clearly targeted these areas of interest, the test is validated.

External Validity

According to Campbell and Stanley (1963), external validity addresses the question of generalizability: To whom can we generalize the study's findings? Since the scope of this study focuses on the perspectives of a small number of teachers participating in a workshop funded by a regional grant at a local university, the results are only generalizable to a population with similar characteristics to those participating in this study.

Reliability

Quantitative techniques employed in this study began by showing the reliability of the survey instrument used in this study. Second, I have discussed factor analysis used in an attempt to cluster the survey questions analytically using SPSS version 15.0 and the process actually used to cluster the questions for this study. Finally, I have discussed the close-ended responses given by the participants about their perspectives of the effectiveness of Lesson Study on their teaching and student achievement through an analysis of the descriptive statistics gleaned from the responses.

Hittleman and Simon (2006) define *reliability* as "the extent to which test scores are consistent; that is, the degree to which the test scores are dependable or relatively free from random errors of measurement" (p. 309). Before beginning the analysis of data collected by the survey instrument, I believed it prudent to begin by testing the reliability of the survey instrument itself. The interest for an establishment of reliability of instruments comes from the necessity that the same set of items would elicit the same responses if the same questions were recast and re-administered to the same respondents. Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the variable being measured (Hatcher, 1994). According to Santos (1999), "alpha coefficients range in value from 0 to 1 and may be used to describe the reliability of factors extracted from questions with Likert scales. The higher the score, the more reliable the generated scale is" (p. 2). Nunnaly (1978) has indicated 0.7 to be an acceptable reliable coefficient. A statistical analysis of reliability of the survey instrument's thirteen close-ended questions (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 16, 17, 18) returned an alpha of 0.854. Based on Nunnaly's (1978) benchmark, this alpha ranks reasonably high; thus the survey instrument is judged reliable.

In order to determine whether the close-ended questions on my survey would statistically cluster into the categories indicated by the study's research questions, I performed a principle axis factor analysis. Because of the three research questions in this study, I anticipated the analysis to yield three factors (or clusters) indicating that the questions in the survey are asking about three general topics. However, I would have been satisfied discovering that there were two factors since content and pedagogical knowledge could be defined as "teaching" (the first factor); student achievement would be the second factor. Rather than placing any restrictions on the analysis, I first performed the factor analysis without specifying the number of factors. After 100 iterations, the extraction was terminated by SPSS. Since that method did not work, I decided I would tell SPSS how many factors I was expecting and wanted to see if it could statistically reinforce my conjecture of having two or three factors. Again, after 100 iterations, the extraction was terminated by SPSS. Kerlinger (1986) writes the following of factor analysis sample sizes:

> Two desiderata, even necessities, of factor analysis are large samples and replication. A general rule is: Use as large samples as possible. Like any statistical procedure, factor analysis is subject to measurement and sampling error, and the reliable identification of factors and factor loadings requires large *N*'s to wash out error variance. … A loose but not bad rule-of-thumb might be: ten subjects for each variable (item, measure, etc.). (p. 593)

Given the number of questions in this survey, the minimum number of participants required is 130 participants. With only n=34, the statistical factor analysis through SPSS was not possible, hence the terminations after 100 iterations. Therefore it became necessary to find another means of clustering the survey questions into factors for answering the study's research

questions. Per the recommendation of my committee members, I divided the questions into clusters and then asked two others, one of my committee members and another doctoral student in mathematics education, to do the same. The survey questions that we correlated to the respective research questions were taken at face value. For those where we disagreed, we met together to discuss our differences of opinions and were able to come up with a consensus of why we clustered the questions the way we did. The final clustering of survey questions per research question is located in tables eleven, twelve, and thirteen in chapter three.

Once the survey questions were clustered, I performed a statistical analysis to determine teachers' perspectives of Lesson Study on their content knowledge, pedagogical knowledge, and students' achievement.

Chapter Summary

This study aims at investigating whether or not teachers believe Lesson Study to be affecting their content knowledge, pedagogical knowledge, and student achievement. In this chapter I have described the design of the study, the research questions, and the instrumentation. I have also described the participants, their selection method, and procedures for obtaining their responses. Next I discussed the limitations, delimitations, and bias monitoring. Lastly, I discussed the data analysis procedures, internal validity, and external validity.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

I would be hard-pressed to find another method of increasing
student achievement beyond the Lesson Study Process of taking a lesson,
collaborating on its development, teaching it to the students, revising it,
teaching it to a different set of students, and then continuing
to revise the lesson until its published.
(Will[3], focus group participant in this study)

Introduction

In this chapter I present the findings of the analysis of the data included in two sections: (1) the quantitative findings which present and discuss the results of the statistical analyses and (2) the qualitative findings which describe the teachers' perspectives on Lesson Study. The format of the quantitative section includes a discussion of the reliability of the survey instrument, the manner in which the items on the survey were correlated to the study's research questions, and discussion of the results. The format of the qualitative section includes a description of the participants in the focus group sessions, the environments where the focus group sessions took place, and an examination of the data relative to the research questions. The research questions guiding this study are the following:

1. What are the perspectives of teachers on the impact of Lesson Study on their mathematical content knowledge?
2. What are the perspectives of teachers on the impact of Lesson Study on their pedagogical knowledge?
3. What are the perspectives of teachers on the impact of Lesson Study on their students' achievement?

[3] Pseudonyms were used throughout this study when referring to research participants.

The following sections discuss the responses to the survey questions regarding the teachers' perspectives of the Lesson Study Process on teaching and student achievement. The sections are divided by research questions.

Research Question #1

The first research question related to teaching is: What are the teachers' perspectives on the impact of Lesson Study on their mathematical content knowledge? Table 15 contains descriptive statistics from the five survey questions correlated to the first research question. Because the Likert scale used in question seventeen (10-point) was different from the other three (4-point), I transformed survey question 17 so that all of the items could be compared to one another. Using elementary algebra, I converted the mean statistic of question 17 from 8.70 to 3.48 so that all five of the items could be compared.

Table 15: Descriptive Statistics of Responses for Research Question 1

Question No.	Mean	Std. Deviation
2	3.47	.563
7	3.26	.618
8	3.50	.564
9	3.50	.615
17	3.48	1.811
Grand Mean*	3.442	

Note: The Grand Mean score was calculated after the mean statistic when Question 17 was transformed.

The Grand Mean (or mean of the five questions' means) is 3.442 out of 4.000 indicating that the teachers agreed that Lesson Study positively affects their content knowledge. Based on the standard deviations in the table above, the participants' responses were homogeneous—no more than 0.618 standard deviations from the mean in the questions using a 4-point Likert scale and no more than 1.811 standard deviations from the mean in question 17 using a 10-point Likert

scale further reinforcing that the teachers "Agree" that Lesson Study positively affected their content knowledge.

Research Question #2

The second research question related to teaching is: What are the perspectives of teachers of the impact of Lesson Study on their mathematics pedagogical knowledge? The following table contains descriptive statistics from the seven survey questions correlated to the second research question. Because the Likert scale used in question sixteen (10-point) was different from the other three (4-point), I transformed survey question 16 so that all of the items could be compared to one another. Using elementary algebra, I converted the mean statistic of question 16 from 8.88 to 3.552 so that all seven of the items could be compared.

Table 16: Descriptive Statistics of Responses for Research Question 2

Question No.	Mean	Std. Deviation
1	3.43	.504
2	3.47	.563
3	3.41	.500
6	3.68	.649
9	3.64	.615
10	3.67	.613
16	3.58	1.341
Grand Mean*	3.552	

Note: The Grand Mean score was calculated after the mean statistic when Question 16 was transformed.

The Grand Mean (or mean of the seven questions' means) is 3.552 indicating that the teachers agreed that Lesson Study positively affects their pedagogical knowledge. Based on the standard deviations in the table above, the participants' responses are homogeneous—no more than 0.649 standard deviations from the mean in the questions using a 4-point Likert scale and no more than 1.341 standard deviations from the mean in question 16 using a 10-point Likert scale

further reinforcing that the teachers "Agree" that Lesson Study positively affects their content knowledge.

Research Question #3

The third research question is: What are the perspectives of teachers of the impact of Lesson Study on their students' achievement? The following table contains descriptive statistics from the three survey questions correlated to the third research question. Because the Likert scale used in question eighteen (10-point) was different from the other three (4-point), I transformed survey question 18 so that all of the items could be compared to one another. Using elementary algebra, I converted the mean statistic of question 18 from 8.79 to 3.516 so that all three of the items could be compared.

Table 17: Descriptive Statistics of Responses for Research Question 3

Question No.	Mean	Std. Deviation
4	3.50	.508
5	3.34	.545
18	3.516	1.317
Grand Mean*	3.452	

Note: The Grand Mean score was calculated after the mean statistic when Question 18 was transformed.

The Grand Mean (or mean of the three questions' means) is 3.452 indicating that the teachers agreed that Lesson Study positively affects student achievement. Based on the standard deviations in the table above, the participants' responses are homogeneous—no more than 0.545 standard deviations from the mean in the questions using a 4-point Likert scale and no more than 1.317 standard deviations from the mean in the question using a 10-point Likert scale further reinforcing that the teachers "Agree" that Lesson Study positively affects their content knowledge.

Summary of Quantitative Findings

Based on the data described above, the teachers participating in this case study believe that their content knowledge, pedagogical knowledge, and students' achievement are being positively affected by the Lesson Study Process. The following table lists the ranking of the teachers' perspectives on Lesson Study effectiveness.

Table 18: Ranking of Lesson Study Effectiveness Based on a 4-Point Scale

Rank	Research Question Topic	Grand Mean
1	Pedagogical Knowledge	3.552
2	Student Achievement	3.452
3	Content Knowledge	3.442

Based on the 4-point Likert scale that was used to measure the teachers' perspectives on the effects of the Lesson Study Process on their teaching and student achievement, these statistics clearly indicate that the research participants believe that participating in Lesson Study improves these areas. Specifically, the teachers believe that their pedagogical knowledge is affected the greatest by Lesson Study, their students' achievement is affected second greatest, and lastly, that their content knowledge is affected third greatest by Lesson Study. Although there is not a statistically significant difference between the three grand means, it is worth mentioning how the three ranked against each other. In the interest of triangulating the data—from a quantitative and qualitative means—the qualitative data ranks the effectiveness of Lesson Study through this study's research questions identically.

Qualitative Research

According to Denzin and Lincoln (2003), using the word *qualitative* indicates a stress of the qualities of entities on process and meaning that are not experimentally examined or measured in terms of quantity, amount, intensity, or frequency. Rather, qualitative research is used to gain insight into participants' attitudes, behaviors, value systems, concerns, motivations, aspirations, culture, or lifestyle. Qualitative researchers "seek answers to questions that stress *how* social experience is created and given meaning" (Denzin & Lincoln, 2003, p. 13). The previous section on quantitative findings provided statistics indicating the level of agreement of the teachers participating in this study with the statements provided to them in the survey instrument. This section seeks to probe for a deeper understanding of the teachers' perspectives through an analysis of the responses provided during opportunities for reflection on the Lesson Study Process through open-ended questions via a survey, questionnaire, and focus group discussions with me and their Lesson Study colleagues.

Description of Focus Group Participants

There were three focus group sessions conducted during the course of this study. The first was held during the summer of 2007, the second was held during the summer of 2008, and the last one was held during the fall of 2008. The following tables contain relevant demographic information about each participant's professional career at the time of the focus group session. As indicated by the tables, the participants had varied backgrounds in grade levels being taught, ranging from kindergarten through eleventh grade. They also represent a range of teaching experience, from one to thirty-four years. Lastly, the tables indicate the participants' content area(s) and type of school environment—private or public.

Table 19: 2007 Focus Group A Participant Demographics

Participant	Teaching Experience	Grade Levels	Content Area	Type of School
Connie	28	1-5[4]	Mathematics	Public
Kimberly	5	6	Mathematics	Public
Ashley	17	3	Mathematics, Science, ELA[5]	Public
Kay	7	4	Mathematics, ELA	Public
Cinda	15	K	All Subjects	Public
Sue	12	2	All Subjects	Public
Linda	11	6-8	Mathematics	Public
Nelda	4	1	All Subjects	Public
Monroe	3	K-3	Special Education	Public
Carolyn	1	3	All Subjects	Public
Rosetta	32	7	Mathematics	Public

[4] Mathematics Coach

[5] English Language Arts (ELA)

Table 20: 2008 Focus Group A Participant Demographics

Participant	Teaching Experience	Grade Levels	Content Area	Type of School
Caroline	6	7	Mathematics	Public
Brenda	20	K-5[6]	Mathematics, Literacy	Public
Rosalyn	14	3-4	Mathematics, Literacy	Public
Brandi	24	K-4	Special Education	Public
Jane	14	4	Mathematics, Literacy, Social Studies	Public
Laurie	9	6-7	Mathematics	Public
Mallory	20	3-4	Mathematics, Science, French, Social Studies	Public
Madelle	1	4-5	Mathematics	Public
Altha	34	6-7	Mathematics	Private

[6] Professional Development Resource Teacher

Table 21: 2008 Focus Group B Participant Demographics

Participant	Teaching Experience	Grade Levels	Content Area	Type of School
Altha	34	6-7	Mathematics	Private
Will	2	7	Mathematics	Public
Raymond	12	7-8	Mathematics	Public
Sydney	9	10-11	Mathematics	Private
Rosalyn	14	3-4	Mathematics, Literacy	Public
Laurie	9	6-7	Mathematics	Public
Brandi	24	K-4	Special Education	Public
Mallory	20	3-4	Mathematics, Science, French, Social Studies	Public
Lori	14	4	Mathematics, Literacy, Social Studies	Public

Potential Bias of Participants

Each of the participants came to the Lesson Study institute and participated in the surveys, questionnaires, and focus group sessions voluntarily. Each knew in advance that this research investigated Lesson Study as a form of teacher professional development and each willingly participated in the study. They participated in the Lesson Study institute to improve their teaching; their attitudes while working with all involved reflected their enthusiasm for more effective teaching. Each of these teachers demonstrated professionalism and competency and thus spoke with confidence and conviction about their Lesson Study experience.

In addition, any discussion of participants in the qualitative portion of a study compels a discussion of potential biases. According to Patton (2002), participants who volunteer for research studies may be biased for or against the subject of interest. Thus, he adds, researchers should identify those who volunteer too eagerly to participate in a study. Because the purpose of this study is to bare the subjective perspectives of the teachers on their experiences with Lesson Study, this fact does not invalidate the study.

Qualitative Findings

As in any study using qualitative research methods, my instruments' questions were designed to probe for a deeper, richer understanding of teachers' perspectives on Lesson Study. During the focus group sessions, the teachers were highly engaged—often finishing each other's sentences, continuing in the same vein as the previous participant had been speaking. Similarly, the participants shared a great deal through writing on the questionnaires and open-ended sections of the survey. Paralleling the quantitative findings of this study, these findings also

suggest that the teachers believe that Lesson Study positively impacts their content knowledge, their pedagogical knowledge, and their students' achievement.

At the core of qualitative data analysis, according to Ryan and Bernard (2003), is the discovering of themes. Other theorists refer to them as "categories" (Glaser & Strauss, 1967). Ryan and Bernard (2008) discuss four techniques used in discovering categories which I quote here:

1. An analysis of words (word repetitions, key-indigenous terms, and key-words-in contexts);
2. A careful reading of larger blocks of texts (compare and contrast, social science queries, and searching for missing information);
3. An intentional analysis of linguistic features (metaphors, transitions, connectors); and
4. The physical manipulation of text (unmarked texts and cut and sort procedures) (p. 2).

For the purpose of this study, the *categories* emerge from the raw data in the form of related phrases, sentences, or conversations. According to Bogdan and Taylor (1975), themes are comprised of similar concepts that are repeated over and over in a collection of data. Therefore, from these categories I have labeled *themes* to describe the major categories being discussed by several of the teachers.

After the segregation of the responses by research question—this process was discussed previously—I read through the transcriptions and written answers twice, noting any keywords that were being repeated by the research participants. An analysis of the focus group sessions proved more difficult than the responses on the surveys and questionnaires. As Glaser (1978)

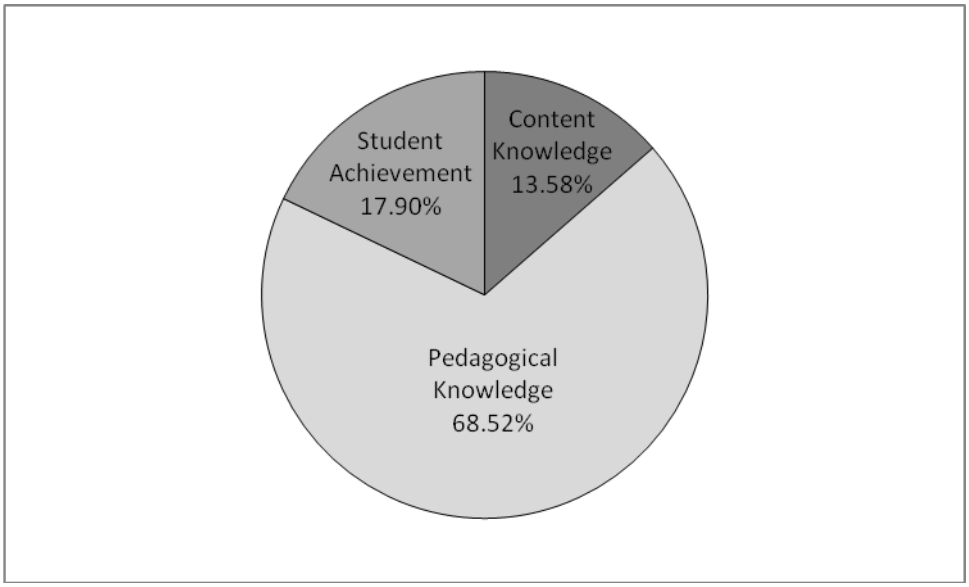
describes, I examined each sentence from the focus group transcriptions by asking myself the following questions, "What is this about? How is it similar to or different than the preceding or following statements?" Lincoln and Guba (1985) suggest identifying "*units* of information that will, sooner or later, serve as the basis for determining categories" (p. 344). Merriam (1988) writes that "Units come from interview transcripts, observation notes, or documents. A unit can be a phrase, a sentence, a paragraph" (p. 132). For this study, the responses from the questionnaires and surveys proved easy to segregate into units and categories because the questions on those two instruments asked a specific question.

The responses from the focus group sessions, however, proved a bit more challenging. Rather than having a strict number of questions, focus groups are *guided* by questions—i.e., the moderator has a list of topics s/he is seeking to discover information about, but should carefully listen and probe deeper by asking additional, ad hoc, questions as the situations arise. Additionally inherent in the nature of focus group sessions is the manner in which the participants respond to each other. A conversation may begin with one topic and by the end of the dialogue may have spiraled into something unrelated to the guiding question. For this reason, determining where the idea units begin and end can be tricky. The researcher is required to read through all of the data many times and determine to the best of his/her ability where one unit ends and another begins (Spradley, 1979). At times, the dialog between the focus group participants proved easy to segregate, other times, it became a matter of reading, re-reading, listening to the audio recordings, asking for assistance from my committee members, and finally using my best judgment. Using the same peer review technique employed throughout this study, the reliability of this technique is strengthened through objectivity.

After deciding where to segregate the responses by categories, I labeled each response with a category name. Finally, I began segregating the responses by the categories and classifying themes. After the preliminary analysis was done, I reexamined the classification system to ensure consistency within the body of data. In order to promote trustworthiness within this data classification system, I employed a form of peer review whereby I asked another doctoral candidate in mathematics education to review the data with its categories and themes to verify that my classification system was correct. After she finished, we met together and discussed any dissimilar classifications of data. The final categorization of data we agreed upon is presented in the following sections of this chapter.

There were a total of 162 idea units dealing specifically with teachers' content knowledge, their pedagogical knowledge, and student achievement. The responses collected that were beyond the scope of this study—i.e., not pertaining the research questions—were culled from the data set to be analyzed and are listed in Appendix F. Certain themes began to emerge from the data after reading through the data multiple times. In order to verify the categorization in which I classified the responses, I asked another doctoral student in mathematics education to perform the same analysis. We held a meeting to discuss any discrepancies found between our classification and came to a consensus of the final categorization found in this study. The frequency of responses can be found in Figure 3.

Figure 3: Percentages of Responses by Research Question Topics



Certain themes began to emerge from the teachers' responses as to how they believed that their content knowledge, pedagogical knowledge, and student achievement were improving after carefully sifting through the transcriptions of the focus group sessions and the responses written on the surveys and questionnaires. Specifically, 68.52% of the responses dealt with pedagogical knowledge, 17.90% dealt with student achievement, and 13.58% discussed teachers' mathematics content knowledge. The following sections are an explanation of my findings.

Research Question #1

The first research question of this study is:

> What are the perspectives of teachers of the impact of Lesson Study on their mathematical content knowledge?

In the interest of the trustworthiness of these data clusters, table 22 presents the research participants' responses segregated by the emerging categories.

Table 22: Qualitative Responses to Research Question #1 by Category: Content Knowledge

Category	Research Instrument	Responses
Deeper Understanding	Survey	• I have gained a deeper understanding of mathematical concepts. • The lesson study process has affected my approach to learning math by allowing me to see math more visually than I had before participating in the lesson study process.
	Focus Group A	• Learned different ways of looking at how to divide or a certain topic/content. • Different ways of thinking about the process. How I think about it is not necessarily how my students look at it. More than one process of coming up with the correct answer. • We all said things in a different way. All had our different take on something but all said the same thing.
	Focus Group B	• For me, I've learned how to do more math but I was discovering more ways of doing the same math… the things that I had never really done with the manipulatives—not that I was afraid of them—but then linking my deep understanding of math as it is to the hands-on manipulatives that the students would use… the result was that I had this growth to new ways of thinking about certain math concepts. Taught me new ways of understanding how to do certain things – not just one way of doing them. • So what I'm saying is that the conceptual understand of what I'm teaching is growing rather than applying one hard-fast algorithm for solving a particular type of problem. Instead I'm learning more than one way of looking at particular types of problems. • I've learned different ways of looking at how to work certain problems, new ways of thinking about the processes. How I think about them is not necessarily how my students look at them. I've learned new ways of methods of arriving at the correct answer. • We'd never done division of fractions this way. It makes sense! But the reason that we do multiplying first is because not all problems work out so nicely. But some problems do – where you can divide them directly… and I had never thought about that before until I had to anticipate how students were going to learn things … and became acutely aware of paying attention to the students' learning process.
Affirmation	Survey	• By participating in Lesson Study I am increasing my knowledge of math. • Lesson study has certainly changed my learning of math.
	Questionnaire: Using the Lesson Study Process, is your content knowledge of mathematics changing?	• Yes! It has helped to improve my content knowledge. • My content knowledge has increased. • Yes. • Yes. • My content knowledge of mathematics is changing.
	Focus Group A	• Our mathematics content knowledge is improving as a result of this institute.

Table 22, continued

Confidence	Survey	• It is tearing down a wall for me. It is taking away my fear of math. • This helps me to teach with confidence that I am able to explain in detail these concepts to my students. • The lesson study helped me to be more comfortable with math.
	Questionnaire	• It has also helped to boost my own self-confidence regarding math. • The more I work with higher level mathematics the more comfortable I feel.

Table 23 lists the categories which emerged from the teachers' responses to the questions or through dialogue with each other that dealt specifically with Lesson Study impacting their mathematical content knowledge.

Table 23: Categories of Qualitative Responses to Research Question #1: Content Knowledge

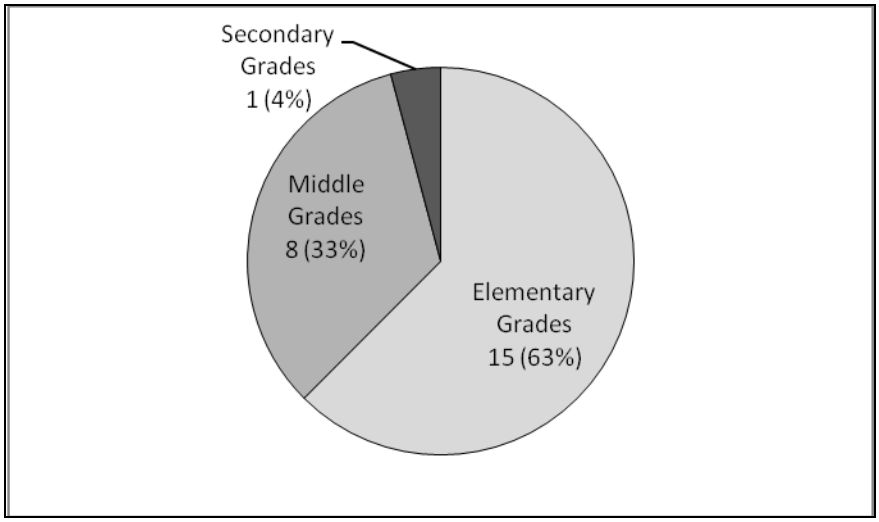
Categories	**Frequency of Idea Units**
Deeper Understanding	5.56% (9 of 162)
Affirmation	4.94% (8 of 162)
Confidence	3.09% (5 of 162)
TOTAL	13.58% (22 of 162)

Deeper Understanding

Nine of the total responses relating specifically to the research questions of this study indicated that teachers believe that they gained a deeper understanding of mathematics content knowledge after participating in the Lesson Study Process. The total of these percentages equals less than fifteen percent of the total responses, but is understandable given that the majority of the teachers involved in this study taught elementary school mathematics whose content does not typically rise above that of a sixth grader. Had this study included teachers from higher level mathematics courses, the amount of increased content knowledge could have been greater. Additionally, there is a likelihood that the teachers who signed up for such an intensive form of

teacher professional development were, themselves, already teachers possessing a high level of knowledge of content for their grade level. Figure 4 illustrates the break-down of teachers by grade level: Elementary Grades (K-5), Middle Grades (6-8), Secondary Grades (9-12).

Figure 4: Teachers Participating in the Focus Group Sessions by Grade Level



Specifically, the teachers who answered this way believed that they had gained a deeper understanding of working mathematical problems from different perspectives due to collaboration with others. During one of the focus group sessions, Lori said:

> I have learned different ways of looking at how to work certain problems, new ways of thinking about the processes. How I think about [working certain types of problems] is not necessarily how my students look at them. I have learned new ways or methods of arriving at the correct answer.

Deepening one's understanding of mathematics through collaboration is an important facet of differentiated learning. Since students construct knowledge differently, it is important that teachers have deeper understanding of working mathematics problems such that they are able to

show their students multiple ways of solving them in a manner that is clearest to them. Another teacher said:

> For me, I have learned how to do more math and have discovered more ways of doing the same math… I had this growth to new ways of thinking about certain math concepts. [The Lesson Study Process] taught me new ways of understanding how to do certain things – not just one way of doing them.

In essence, what the teachers are saying about the Lesson Study Process deepening their understanding of their mathematics content knowledge is that they are gaining a heightened conceptual understanding of what they are teaching such that after participating in the Lesson Study Process they are able to work through mathematics problems using multiple methods now.

Other Categories

Affirmation and *Confidence* were the other two categories of responses that emerged from the teachers' responses. *Affirmation* in this sense is the category I used when teachers answered affirmatively to questions relating content knowledge on the questionnaire. In an open forum, such as a focus group session, richer data could have been collected rather than a one-word answer. Five of the respondents believe that the Lesson Study Process makes them more confident with the content knowledge that they already possess. In one of the focus group sessions, Cinda, a teacher working in a group across grade levels said:

> The more I work higher level mathematics with the other teachers the more comfortable I feel. Teaching kindergarten can make someone quite rusty in math skills. This process has forced me to use mathematics in ways I don't do on a day-to-day basis. This also helped me when planning my kindergarten lessons.

Additionally, one of the research participants answered one of the questions on the survey with the following statement:

"Lesson Study is tearing down a wall for me. It is taking away my fear of math." Finally, another teacher said, "This helps me to teach with confidence that I am able to explain in detail these concepts to my students." This teacher believes that as his/her confidence in mathematics content increases, the more effective s/he becomes as s/he is able to explain a more conceptual understanding of the mathematics content to his/her students. This statement given by this respondent directly relates teachers' content knowledge with his/her effectiveness as a mathematics teacher. Lastly, one teacher responded:

> I have gained a deeper understanding of mathematical concepts. It has made me more mindful of the types of lessons I create for my students. It has also helped to boost my own self-confidence regarding math. It is tearing down a wall for me. It is taking away my fear of math.

To summarize this category, the teachers discussing their confidence levels believe that by working with teachers across multiple grade levels they are forced to work through problems with students at other grade levels. Therefore, brushing up on these math skills that may have lain dormant, provided them with a new sense of confidence in their mathematics content knowledge.

In summary of this research question, the perspectives of the teachers are that their content knowledge is indeed increasing as a result of the Lesson Study Process. First, the teachers said that they are gaining a deeper understanding of mathematics content than they previously possessed by working collaboratively with other teachers who may have different ways of working certain types of problems. This deepening of their content knowledge provides

them with the ability to teach students multiple ways of representing mathematics concepts. Second, the teachers said that they are gaining more confidence in their mathematics content knowledge from the collaborative effort that is inherent in planning Research Lessons. By working with teachers from other grade levels than their own, they are required to work math problems outside of their own grade level thus brushing up on mathematics content that may have heretofore lain dormant.

Research Question #2

The second research question of this study is:

> What are the perspectives of teachers of the impact of Lesson Study on their mathematical pedagogical knowledge?

In the interest of the trustworthiness of these data clusters, the following table presents the teachers' responses segregated by the emerging categories.

Table 24: Qualitative Responses to Research Question #2 by Category: Pedagogy

Category	Research Instrument	Responses
Planning	Survey	• By planning and anticipating the students' questions and responses I am more in tune with their likes and dislikes. • Planning lessons to this degree gives you more information when teaching the lessons. • The lesson study planning helped me get more involved in the students' actual learning. • This planning process allows teachers to carefully look at lessons and student achievement. • The lesson study process allows you time to fine tune a lesson. It helps you to create a lesson that will both challenge and engage your students. • This type of planning has helped me to see the flow of a smooth lesson. • The lesson study has affected my learning of math by providing me with new strategies of planning, teaching and also increasing my knowledge of math. • I feel I put more thought into planning and questioning • I focus on every aspect of the lesson in sections to build a whole lesson. • I liked the planned questions and collaboration of ideas.

Table 24, continued

Planning, continued	Questionnaire	• Through this type of lesson planning I believe that I structure my lessons according to my students' needs rather than what I believe they are. • I plan more student experiences that will help build their core understanding of mathematical concepts. • When planning like this I am less likely to leave out important concepts. • Lesson Study has allowed me to plan using high order thinking questions. • By planning the lesson with others I have been provided with new ways to teach various concepts. • The Lesson Study process has made me go back to my "roots." We learned how to plan like this in school but rarely put this much detail into it. • This is teaching us to go back and look at how to teach the lesson.
	Focus Group A	• Instead of writing in that little box we are putting more effort into the format—the steps and prerequisite skills—of lesson planning. • Requires more than writing your thoughts. Forces you to study. • We're so used to that little box, the template. Lesson Study brings about new ideas of what a lesson plan template should be. Maybe that box is for you to refer to every now and then but that concept is really wiped out. • How often do you really do that by yourself? But with Lesson Study, you were more apt to plan like that [another teacher referring to the previous response]. • Forces you to be a little more thoughtful in how you're presenting a lesson.
	Focus Group B	• We're no longer planning to stand up and lecture the students. • And having that in the Lesson Study Process, I can relate to completely because I tried to follow the script a little too much and afterward felt that I missed this opportunity, I missed that opportunity, and instead of letting the students try my instruction, because as we know in the classroom you can have the best laid plan, and the students who either they are getting a concept or not getting a concept you may have to go back and say ok what is it that I need to do right now to make sure that they're understanding what was going on and this Research Lesson planning is giving us the opportunity to try that first and next time it's going to be awesome. They can't help but be fabulous. You know what to do, what your mistakes have been, and next time it's there to really help you out. • I think the planning process is something that should be put in place in your school and even in your district where you can have in-house professional development. • This is about connecting things in our curriculum planning… to improve the way that we teach across the board.

Table 24, continued

Planning, Curriculum	Survey	• I teach kindergarten. Working with the first grade teachers has made me re-evaluate the content that I am planning for my students. I am very conscious of making certain that I am teaching my students and preparing them for the next grade level. • When preparing a lesson we had to review STSB's curriculum GLE's in order to achieve goals intended. • Lesson Study impacted my knowledge because in order for me to understand where my children came from and what they are expected to do in the future I had to cross reference my knowledge with GLEs from other grade levels.
	Focus Group A	• I think the whole idea of the Lesson Study is excellent in what it brought to focus for me is the curriculum alignment. I became so aware what the sixth grade teachers are doing, and what the 3rd, 4th and 5th grade teachers were doing related to that in the classroom. I think that is one of the best things for me to think about—the curriculum alignment. What they need to know—that foundation—starting in kindergarten. • The in-depth look at what it is we're going to teach. Not only what we're going to teach but the whole process… the other people involved in terms of getting the kids where we want them to be. You can't just consider your little moment in time as a teacher but consider the entire sequence of the entire curriculum. • Our knowledge of the grade level pre-requisites is being expanded.
	Focus Group B	• We look at iLEAP, LEAP scores, we interview teachers, we came to the conclusion that *x* was a skill across the board that needed more attention to bring up the scores, to affect student learning. So we researched that, we got all of our scores from the principal, went through the strands, specifically what topic in measurement needed more improved instruction to help improve the grade. • Part of this process, you can't just take one grade in isolation. We had to go through K, starting at the base level with time, which is what we had to know what the foundation was and go with that all the way through and then chose a grade level that would have the greatest impact and go from there. • We had to learn to look at the grade levels above and below. • We look at what we've done, what the kids' needs are–the kids can't do this, they're having trouble with this. We're trying to align what we're doing in 2nd and 3rd and 4 & 5th into a curriculum map for the school in math in particular. So that then x y & z, in 3, 4th & 5th are pretty much on Unit of Measure at the same time and we're able to discuss situations that we're facing… things to keep in mind so that…Ok all you need to go over is to here in 3rd, and I'll pick it up here so that then she can pick it up there in the 5th grade and maybe go broader, or deeper.

Table 24, continued

Planning, Curriculum, continued	Focus Group B, continued	• We need to look at what's most important to teach about this particular topic and what they need to do… and then stick to that as much as we can. That collaboration: You mean we don't have to teach to the hour to the minute in 3rd grade, then I don't have to teach to the second if that's what's covered in 4th. We shouldn't have to overlap so much. We're not tied to that math textbook and we shouldn't feel like we have to cover everything in there just because it's in there. If I'm teaching multiplication or decimals and that's not covered until chapter 11, why do I have to drop it here and then pick it back up in the spring? Why can't I connect these concepts to everything that I'm doing—with multiplication, with division, or whatever. • Moderator: What caused you to go through this process? What I'm trying to get at is this: Did you do this type of textbook alignment with the GLEs before you were involved in the LSP? Rosalyn: I think it's because of our focus in this program and we had to wrap our head around what in math … When you're trying to revamp a math curriculum, it's almost like "where do you start?" and so you have to go through the different areas of the book to find out what's related to each other. It helps give you a push and a focus to work on the curriculum alignment. Where does 1st grade start and stop and move to 2nd … and all the way throughout the school. Everyone brought their textbooks and aligned with GLEs what was covered at each grade level to cut out what was being taught the same way over and over and focus on those things which were lacking the proper amount of depth as indicated by the GLEs. Raymond: Correlate what we're teaching in the books with the LEAP tests and pluck out those things that aren't necessarily needed. Lori: <interrupts> …And what outshoots from each one of them. And what prior knowledge has to be from each grade level as you go up to master that skill.
Planning, Manipulatives	Survey	• I'm more confident in pedagogy and using manipulatives as much as possible. • I'm using different manipulatives. A wide-range of manipulatives with students. These are manipulatives the students (first graders) have never seen before. • I learned how to use manipulatives with fractions. • Lesson Study affected my teaching of math concretely. Because I've never been encouraged ever to use manipulatives personally I really didn't know how useful they could be to student learning. • I provide more use of manipulatives for my students.
	Questionnaire	• Yes, I feel more adequate using math manipulatives. • Yes, I'm planning to use manipulatives more this year. • I feel I understood how to give my student a deeper knowledge of their content skills using exploration and manipulatives. • I feel more adequate using hands-on manipulatives.

Table 24, continued

Planning, Manipulatives, continued	Focus Group A	• Lesson Study is making you more aware of what you're teaching… like how the pattern blocks, etc., are put together to make one [whole] shape. • It's teaching us how to better use manipulatives—shows the thinking process of solving these problems. • One key thing for me was model it one good time so they'll have it. I think they did pretty well but that was critical.
	Focus Group B	• Even though you want to let them go, it's critical to model it one time for them. You've taken all this time to plan the lesson, anticipate the students' questions and anticipated their responses, and what you're saying is even though it's great to let the kids go with it, you still have to show them how the manipulatives can be used.
Planning, Relevancy	Survey	• It made me understand the relationship math has with real world. • I used to just introduce a lesson with an attention getter that had no connection to the lesson - it would just perk attention. Now it is connected to real-world and the lesson. • If there isn't a personal attachment or a real-life connection to what is taught, there is a chance of losing the children. • It has reminded me not to look at math only in terms of numbers, to bring a lot more experiences in for students such as literacy. • It helps you to create a lesson that will both challenge and engage your students. • Through lesson study I have learned about new ways to approach math when teaching and how to keep my students highly engaged through real-life problem solving.
	Questionnaire	• It has helped me to create learning experiences that makes the content meaningful to all students. • Real-world connections were lacking before I began planning my Research Lesson. • If there isn't a personal attachment or a real life connection to what is taught, there is a chance of loosing the children.
	Focus Group A	• The lesson study process has taught me how to create a more meaningful lesson experience for students.
	Focus Group B	• A major part of that is the research that takes place that goes into developing that lesson: A better way to get the content to the children for a higher level of understanding is by making it something that relates to them. Each class is different so the lesson plans have to be slightly different. • Giving them real-world applications promotes better understanding with higher-level thinking skills and high-engagement.

Table 24, continued

Planning, Literacy	Survey	• By combining literacy children are expose to subjects across the curriculum. • Lesson Study has shown me different ways to incorporate vocabulary into my lessons. • Integrate math and literacy using vocabulary. • It has reminded me not to look at math only in terms of numbers, to bring a lot more experiences in for students such as literacy.
	Questionnaire	• I'm integrating math in other subjects, as well as bringing literacy into it. • I need to strengthen the use of vocabulary words.
Collaboration	Survey	• One advantage is collaboration with team members, and opportunities to observe other teaching styles. • An advantage of Lesson Study is having the opportunity to work collaborative with my colleagues and to gain their inputs when the observation is complete. I don't claim to have all the answers so working with others makes my job a little easier because of the solid support. • I have benefitted greatly by other team members and their experiences. • I think the planned questions and collaboration of ideas. • When we are working together we can see where our students need to be in the future and also where they have been in the past. • The collaboration between teachers is very effective. • Working with peers and getting feedback. • You get feedback on what works and what doesn't.
	Questionnaire	• I think if the other teachers would really try to sit down and plan, revise, etc… they would enjoy the collaboration and ideas from everyone else. • Peer teaching can only help with a difficult lesson. Two heads are better than one and teachers working together can share their strengths & weaknesses to improve the lesson. • Peer teaching in my school would help to improve teaching. • Peer teaching will help the teacher and the learner. • We're collaborating more and becoming more aware of our teaching styles as well as the concept of teaching math as a whole.

Table 24, continued

Collaboration, continued	Focus Group A	• Peer teaching is allowing us to see others' approach to the lessons. • Sharing ideas. Tweaking lessons. The lessons will get better. The entire school needs to get involved. • Small groups work better. Find a group that is interested in this. Then when others see it working, they will want to join in. • It takes you away from that closed door emphasis that teachers have always known. You're in your room, you close your door. Moving you away from that. • Lesson Study forces you into collaborative effort. Feel less isolated in what you're doing. • It's good to pick each other's brains. Then someone says something and then it clicks. • Through collaboration, we often found that we all said things in a different way but were trying to do the same thing. I learned more about how to teach from working with others. • Two heads are better than one. Ten heads are even better! The planning of the lessons with the input of the other teachers would be of a big assistance especially if it's a difficult one.
	Focus Group B	• With Lesson Study we have the chance to sit down with colleagues and watch—because we usually are all in our own environments and we don't even know that other people are doing something in their own room. We all assume that we're doing the same thing or not doing the same thing—teaching the same thing but everyone is different. That portion is something that continues … not having the opportunity to watch others corroborate the couple of things that is different; a different way of teaching that helps you. • It's a process of creating your lesson where teachers are collaborating. • The advantage of Lesson Study is the feedback that you receive because normally it's just you and the students. With Lesson Study, you're taken away from the closed-door reality that teachers have always known—you're in your own room and you close your door. We're moving away from that. This forces you into a collaborative effort where you feel less isolated in what you're doing. • It definitely opens the line of communication for us. I run down to the 4th grade teachers' rooms and ask, "What are you doing? And I just did this!" And that definitely helps us be in the same line of thinking. • For me, working with each other after school has increased the techniques I have for reaching my kids. • Based on the LSP of taking a lesson, collaborating on its development, teaching it to the students, revising it, teaching it to a different set of students, and then continuing to revise the lesson until you're satisfied with it… I would be hard-pressed to find another method of increasing student achievement beyond the LSP. • Collaborating is an ongoing form of teacher professional development.

Table 24, continued

Confidence	Survey	• The Lesson Study Process helps teachers to prepare and present a more seasoned lesson that is rich with fun and engaging activities. Student and teachers alike have math phobias but tend to shy away because the lesson is not engaging or it is presented is such a way that it loses them at the onset. The Lesson Study Process helped me to get over some of my uneasiness about math, therefore, I am more confident in my delivery of mathematical concepts.
	Questionnaire	• As my skills improve I can improve my lessons and this helps me to feel more confident in my teaching. • Peer teaching will help the teacher become more at ease with teaching. • I feel more comfortable because of the lesson study. • I feel confident with my lessons. • Yes, especially my comfort zone using math manipulatives.
Affirmation	Questionnaire: Using the Lesson Study Process, is your pedagogical knowledge of mathematics changing?	• Yes. • Yes. • Yes. • Yes. • Yes, I'm learning more about how to teach mathematics better.
Student Thinking / Assessment	Focus Group B	• The one thing for me that is very significant is how you look at assessment and how attached we are to the formal assessment. I've learned how much more you can learn of how much your kids know from other forms of assessment—it all goes into assessment, not just the formal. I've also learned the importance of having your rubric available to the student so they are aware of what you expect in the group projects, the observations, and so on. Now my kids are totally prepared because they know people are observing them for the purpose of assessment. It is also important to also teach the parents that there are other forms of assessment going on so that they're not so attached to the letter grade on one test. • For me, I now look at my students in a different way: Actually looking at how they work on their test [rather than just the correctness of the answers]. I think there's a lot more emphasis now of letting the students discover rather than me always saying this is what we're doing and how we're going to do it. Now I find myself holding back and saying, "Nope, you do it," and focusing on the children more and how they learn instead of just showing them how things work.

Table 24, continued

Dissemination	Questionnaire	• Laurie: Having strong/solid lessons available for others to use is of utmost importance. What I would say my dream vision would be is to have all of these [Research] lessons created by different teachers at different schools, and have an [online repository] for any teacher anywhere. Anybody would be able to use them which will make it easier for teachers anywhere by not having to reinvent the wheel with every lesson. We still have to revamp according to your particular classroom. Rosalyn: <Interrupts> The basic lesson is there and we take it outside of your school building so that anybody who needs something is only one click away. Laurie: You know, I want a good lesson on <motioning with her hands> whatever. I know you have one and I'm going to find it because it's already there. Rosalyn: That's the structure of a research lesson. You know it's already been researched, taught, perfected, and is now available for someone else to use. Moderator: So how is that different from other online repositories that are out there that already say, "Well we've already got a lesson on that." Laurie: <Emphatically pronouncing each word so as to be clear> But those lessons are not research-based.

The following table lists the categories which emerged from the teachers' responses to the questions or through dialogue with each other that dealt specifically with Lesson Study impacting their mathematical pedagogical knowledge.

Table 25: Categories of Qualitative Responses to Research Question #2: Pedagogy

Categories	**Frequency of Idea Units**
Planning	42.59% (69 of 162)
Collaboration	17.28% (28 of 162)
Confidence	3.70% (6 of 162)
Affirmation	3.09% (5 of 162)
Student Thinking / Assessment	1.23% (2 of 162)
Dissemination	0.62% (1 of 162)
TOTAL	68.52% (111 of 162)

Of the categories above, planning and collaboration emerged as major themes. Under the umbrella of planning, teachers believe that the Lesson Study Process positively affects their

1. Planning within the curriculum,

2. Planning with the use of manipulatives,

3. Planning lessons that are relevant to their students,

4. Planning by integrating literacy into their lessons.

These themes are individually discussed in the sections below. Also discussed below is the teachers' perspective that collaboration improves their pedagogical knowledge. Lastly, a brief discussion of the other categories is found in following the discussion of themes. The other categories are confidence, affirmation, student achievement / assessment, and dissemination.

Planning Within the Curriculum

One major theme that emerged from the data was that the teachers believed that the Lesson Study Process helps them plan their lessons within the comprehensive curriculum set forth by the state and the NCTM standards. The teachers believe that collaborating with other teachers—especially those at different grade levels—increases their awareness of how their classroom fits into the larger picture of the mathematics K-12 curriculum. In one of the focus group sessions, Rosalyn said:

> I think the whole idea of the Lesson Study is excellent in that it brought to focus for me the curriculum alignment. I became so aware of what the sixth grade teachers are doing, and what the third, fourth, and fifth grade teachers were doing, and how that related to my classroom. I think that is one of the best things for me to think about: Curriculum Alignment—what they need to know, that foundation, starting in kindergarten.

Based on this and other similar responses, it is clear that the teachers believe that collaboratively planning with teachers from multiple grade levels gives them a distinct advantage of learning how their grade-level fits into the comprehensive mathematics curriculum. Another teacher from the same school continued with the following statements:

> We need to look at what's most important to teach about this particular topic and what [the students] need to do and then stick to that as much as we can. The collaboration provides just that: When teaching time in third grade, we don't have to teach to the second if that's what's covered in fourth grade. We shouldn't overlap so much.

Becoming aware of the comprehensive curriculum provides teachers with the freedom to spend time laying a solid foundation for the grade level expectations (GLEs) instead of trying to cover everything in a certain text book aimed at hitting many mathematics topics briefly. Rosalyn continued by saying that Lesson Study:

> gives you a push and a focus to work on the curriculum alignment. Where does first grade start and stop and move to second grade—and all the way through the school? [All of the teachers participating in Lesson Study from our school] brought their textbooks and aligned with the GLEs what was covered at each grade level to cut out what was being taught the same way over and over and focus on those things which were lacking the proper amount of depth as indicated by the GLEs.

In essence, these teachers indicated that the planning aspect of the Lesson Study Process lent itself to aligning their grade-level mathematics content within the comprehensive curriculum. Rather than only using the state-mandated GLEs, these Lesson Study teachers from multiple grade levels were able to collaborate on where they should start and stop the instruction based on the previous and subsequent teachers' planning within the curriculum. This allows the teacher to spend a more appropriate amount of time teaching those topics which are meant to be taught per each grade level.

Planning with the Use of Manipulatives

The second major theme that emerged from the data was that the teachers believed that they made an effort to plan more hands-on lessons in the Lesson Study Process. Manipulatives allow teachers to design environments where constructivist learning can be well integrated into their lessons. Brenda said, "Within the Lesson Study framework I feel I understood how to give my students a deeper knowledge of their content skills using exploration through manipulatives." Allowing students to explore concrete examples may better lay a solid foundation when transitioning toward abstract mathematics.

Collaboratively planning allowed the teachers to increase their pedagogical knowledge by highlighting how manipulatives can be used to teach students in new ways. For example, Caroline said, "Because I've never been encouraged to use manipulatives with my students, I really didn't know how useful they could be to student learning." According to Clements and McMillen (1996), manipulatives can help students actively construct knowledge when they are given the opportunity to work alone or with each other on a problem requiring hands-on interaction. Engaging students with manipulatives may be considered an effective alternative to rote instruction by allowing students to construct their own knowledge of mathematics themselves.

In summary, these research participants indicated that their knowledge of the appropriateness of manipulatives in mathematics instruction is increasing as a result of collaboratively planning within the Lesson Study Process. While planning their Research Lessons, the teachers are able to share ideas of how to most effectively use the manipulatives they have to enhance student learning.

Planning Lessons That Are Relevant to Their Students

The third major theme that emerged from the data was that the teachers believed that the Lesson Study Process gave them the impetus to create lessons that were more relevant to their students, having more interest to the students. Inherent in the Lesson Study Process is the search for better techniques for teaching. Current pedagogies encourage teachers to develop lessons with examples and other devices that draw upon the students' interests, thus with the hope of engaging the students more fully. In one of the questionnaire questions, Sydney wrote that "if there isn't a personal attachment or a real-life connection to what is taught, there is a chance of losing the children." In the last decade the NCTM has published many articles about the need for relevant lessons in order to better connect with the students for a more thorough engagement in the learning activities. Lesson Study is one such process that encourages teachers to create this type of meaningful lesson for their students.

In summary, the teachers thought that planning lessons within the Lesson Study Process gave them the necessary push to make lessons more relevant to their students. By planning the lessons with relevant, real-world examples and applications of the content being covered they mentioned that their students are more likely to take a vested interest in what is being covered, thus improving the likelihood of increasing student achievement.

Planning by Integrating Literacy into Their Lessons

The final theme that emerged from the data was that the teachers believed that by participating in the Lesson Study Process they were encouraged to incorporate literacy into their mathematics lesson plans. Similar to the previous theme regarding the integration of manipulatives when appropriate, the NCTM and state associations of teachers of mathematics

encourages the incorporation of literacy into all aspects of the comprehensive curriculum. Will wrote on his survey that the Lesson Study Process "has reminded me not to look at math only in terms of numbers, but to bring a lot more experiences in for students such as literacy." Mallory answered a question on the survey similarly: "I'm integrating math into other subjects, as well as bringing literacy into it." The Lesson Study Process enabled the teachers to strive for a higher form of pedagogical development in their classrooms, while heeding the directives of NCTM to encourage and support in adopting effective pedagogies. In essence, these teachers believe that within the Lesson Study paradigm they were more likely to follow the state-level and NCTM thrust to plan their lessons with more ties to literacy and other subjects rather than in isolation.

Collaboration

The previous themes touched upon one very critical part of the Lesson Study Process: Collaboration, emerging as one of its pedagogically beneficial themes. Through collaboration teachers were able to come together and share ideas thus combining the best practices for reaching their students to exemplify that two heads are surely better than one when planning a lesson. During one of the focus group sessions, Mallory said:

> The advantage of Lesson Study is the feedback that you receive because normally it's just you and the students. With Lesson Study, you're taken away from that closed-door reality that teachers have always known—you're in your own room and you close your door. We're moving away from that [paradigm]. This forces you into a collaborative effort where you feel less isolated in what you're doing.

One of the teachers summarized this idea succinctly on one of the surveys: "An advantage of Lesson Study is having the opportunity to work collaboratively with my colleagues

and to gain their inputs once the observation is complete. I don't claim to have all the answers so working with others [to help students] makes my job a little easier because of the solid support."

In essence, the teachers believe and are saying that through the collaborative nature of the Lesson Study Process their teaching is no longer bound by the four walls of their classroom but are able to draw upon the resources of the other teachers with whom they meet. Instead of relying upon one's own pedagogical experience and content-specific expertise, collaborating with other teachers during the Lesson Study Process opens the door to sharing new ideas and discovering new methods of teaching.

Other Categories

Finally, there were several categories that emerged from the data but that do not warrant a brief discussion since their frequency of the responses in this category were significantly lower than the aforementioned themes. Confidence, affirmation, student achievement / assessment, and dissemination are briefly discussed below.

As stated in the previous theme, teachers believe that their confidence in teaching is increasing as a result of participating in Lesson Study. One teacher wrote on the questionnaire: "As my skills improve I can improve my lessons and this helps me to feel more confident in my teaching." As with the first research question, the *affirmation* category simply means that the teachers, when answering the surveys and questionnaires, simply answered that the believed that their pedagogical knowledge was increasing as a result of the Lesson Study Process.

In addition, some of the teachers cited that the Lesson Study Process is responsible for getting them to pay closer attention to how students think rather than whether or not they are answering correctly or incorrectly. As a constructivist form of teacher professional development,

Lesson Study emphasizes that the teacher and classroom observers be more concerned with how the students are receiving the lesson—how they are processing what is being taught to them—in addition to the answers to questions. Raymond said:

> I now look at my students in a different way: Actually looking at how they work on their test [rather than just the correctness of the answers]. I think there's a lot more emphasis now of letting the students discover rather than me always saying this is what we're doing and how we're going to do it. Now I find myself holding back and saying, "Nope, you do it," and focusing on the children more and how they learn instead of just showing them how things work.

Similarly, the Lesson Study paradigm necessitates a shift in the way that students are formally assessed. Laurie spoke in depth about this in one of the focus group sessions:

> The one thing for me that is very significant is how you look at assessment and how attached we are to the formal assessment. I've learned how much more you can learn of how much your kids know from other forms of assessment—it all goes into assessment, not just the formal. I've also learned the importance of having your rubric available to the students so they are aware of what you expect in the group projects, the observations, and so on. Now my kids are totally prepared because they know people are observing them for the purpose of assessment. It is also important to also teach the parents that there are other forms of assessment going on so that they're not so attached to the letter grade on one test.

One teacher mentioned on his or her questionnaire that "having strong/solid lessons available for others to use is of utmost importance." Because of the extensive research that has gone into developing these lessons, Research Lesson plans are set apart from any other lesson

that may appear in many of the online repositories currently in existence. In our final focus group session, several teachers joined in on the following exchange between two teachers from the same school and the moderator:

Laurie: What I would say my dream vision would be is to have all of these [Research] lessons created by different teachers at different schools, and have an [online repository] for any teacher anywhere. Anybody would be able to use them which will make it easier for teachers anywhere by not having to reinvent the wheel with every lesson. We still have to revamp according to your particular classroom.

Rosalyn: <*Interrupts*> The basic lesson is there and we take it outside of your school building so that anybody who needs something is only one click away.

Laurie: You know, I want a good lesson on <*motioning with her hands*> whatever. I know you have one and I'm going to find it because it's already there.

Rosalyn: That's the structure of a research lesson. You know it's already been researched, taught, perfected, and is now available for someone else to use.

Moderator: So how is that different from other online repositories that are out there that already say, "Well, we've already got a lesson on that."

Laurie: <*Emphatically pronouncing each word so as to be clear*> But those lessons are not research-based.

This idea of creating an online repository for Research Lessons will be discussed a bit more in chapter five as the teachers and I believe that making the Research Lessons available to everyone would be one effective means of exposing our students to more well-planned lessons.

In summary of this research question, the perspectives of the teachers are that their pedagogical knowledge is indeed increasing as a result of the Lesson Study Process. First, the teachers said that they are planning more: thoroughly by better aligning their lesson plans within the comprehensive curriculum; appropriate uses of hands-on manipulatives; relevant, real-world lessons to stimulate interest; and lessons that include more literacy components than before entering into the Lesson Study paradigm.

Additionally, these teachers indicated that the collaborative aspect inherent in the Lesson Study Process is critical to increasing their pedagogical knowledge. Also, the teachers indicated that how their students think—specifically when assessing the students—became more important to them since entering the Lesson Study paradigm. Shifting their focus only on whether the students arrived at a correct or incorrect answer to looking at which steps the students took to arrive at the answer provided the teachers with a clearer indication of whether or not the students possess a conceptual understanding of the content they are learning. Finally, the teachers discussed the importance of making the Research Lessons available to other teachers. The final step in the Lesson Study Process is the publication of the lessons. This allows teachers to go to a repository of lessons and modify it so that its content is relevant to that particular class of students.

Research Question #3

The third research question of this study is:

What are the perspectives of teachers of the impact of Lesson Study on their students' achievement?

In the interest of the trustworthiness of these data clusters, the following table presents the research participants' responses segregated by the emerging categories.

Table 26: Qualitative Responses to Research Question #3 by Category: Student Achievement

Category	Research Instrument	Responses
Conceptual Understanding	Survey	• The students may not realize it, but it has really helped them become independent thinkers and problem solvers. • The Research Lesson promoted growth higher achievement skills through a more conceptual learning. • I think that the lesson study I did with my students helped them to comprehend the content more conceptually. • I feel my students have a much better concept and understanding of what I'm teaching.
	Questionnaire	• My lesson included higher order thinking skills, cooperative grouping and word problems. • I'm teaching math with a different perspective hoping that students can learn a more conceptual understanding of what we're learning.
	Focus Group A	• Move beyond the rule. Let *them* do the discovery. Rather than just giving them the rule from the beginning in order to develop a better conceptual understanding. This is a whole new way of teaching the kids.
	Focus Group B	• A better way to teach it, a better way to get the content to the children a higher level of understanding. • Getting them to construct their own knowledge. • They have to be able to explain to me. When they can, that's when I know that they've got a conceptual understanding of what we're doing. When they can't, that's when I have to tell them not to get so frustrated, but to slow down, go back, and they need a little more time… without the immediate gratification. They don't like the negative impact of frustration that is a necessary part of problem solving.

Table 26, continued

Conceptual Understanding, continued	Focus Group B, continued	• It's about allowing them the freedom to be able to interact with each other about ideas and that they don't have to sit in a desk and just pay attention to what you're saying or what's just coming out of your mouth through direct instruction. It's giving them open-ended questioning so that you can say, "Now talk to your group about this," and see what they can come up with. Believe it or not they actually do discuss what you've asked them to discuss and use the manipulatives themselves without me really having to say much where in the past I would have normally said, "Now today we're going to learn blah-blah-blah and construct blah-blah-blah with manipulatives." They'll surprise you with what they're able to construct by working with each other. • It's about allowing them the freedom to be able to interact with each other about ideas and that they don't have to sit in a desk and just pay attention to what you're saying or what's just coming out of your mouth through direct instruction. It's giving them a lot of open-ended questioning so that you can say "now talk to your group about this" and see what they can come up with; they'll surprise you with what they're able to construct.
Planning	Survey	• If we had the opportunity to prepare in depth lessons for all the skills we teach I would say the lesson study would affect student learning/achievement in a positive manner. Unfortunately, the reality of teaching and the way our state approaches teacher preparation each year the lesson study as it is presented now may or may not affect student learning/achievement positively. • Lesson Study affected student learning/achievement because the lesson is carefully thought out from opening to close. This I believe helps long-term memory. • The students are being presented with a lesson that has been created through extensive planning by more than one teacher. This can only benefit their learning. • Lesson study starts with looking at GLEs before you begin and knowing what skills need to be taught for improving student success • The lesson study has a positive impact on student learning and achievement because student data is used to determine lessons. • Because teachers prepare for instruction, the students get a richer and more definite instruction where a lot of questions are answered for the teacher before it is presented to the students. • I think achievement improved because you were able to see the wrinkles in the lesson and go back and fix it and try it again with another class. • The lesson study process allows you time to fine tune a lesson. It helps you to create a lesson that will both challenge and engage your students.

Table 26, continued

Planning, continued	Focus Group A	• To increase student achievement you have to search for something that needs to be focused on for student improvement. Once you find that, you work with a team to develop a lesson that will truly impact your students in a positive way. • Preparing them for the future – not just looking at grade levels before but creating a lesson plan with the entire curriculum in mind. There also has to be a shift from the stigma of principal-observation—where he's grading/critiquing the teacher.
	Focus Group B	• To affect student learning we researched that, we got all of our scores from the principal, went through the strands, specifically what topic in measurement needed more improved instruction to help improve the grade. • We look at iLEAP, LEAP scores, we interview teachers, we came to the conclusion *x* was a skill across the board that needed more attention to bring up the scores, to affect student learning. So we researched that, we got all of our scores from the principal, went through the strands, specifically what topic in measurement needed more improved instruction to help improve the grade. • We have to plan to give them the time and space to work with each other on the concepts that need the most improvement. Then they will be able to excel in those areas.
Observation	Focus Group A	• Collaborative foundation as a school. During the observation we're focusing on the kids. We're interested in noting how they're learning and how to better teach them rather than focusing on the teacher's performance.
	Focus Group B	• Observing a lesson, looking for more ways of trying to polish it to make it better for the students using the technology, manipulatives, and such in that lesson that promotes better understanding with higher-level thinking skills and high-engagement.
Assessment	Focus Group B	• Actually looking at how they work on their test rather than whether the answer is merely right or wrong. • Looking at the students' learning process has made me more aware of how the students think. I'm no longer *mainly* interested in whether or not the students' answers are right or wrong, but how they processed their answer. By having them teach me their ways of doing things, I learn from them but it also helps me identify when students aren't processing the problems correctly and I can go back and correct their misconceptions rather than just assuming that they know what they're doing since they got the questions correctly. Sometimes they think that they can do all of the problems, but they can't. They memorize something that looks like a rule that I should use to make it easier—a shortcut—and they get the question wrong, and then I have to try to undo the damage. I think with the manipulatives, I have to research how they're going to do it because they initially rejected the way to do it… so I have to take more time convincing them that it's ok to get confused and that that's part of the learning process.

Table 26, continued

Affirmation	Survey	• Yes.
Not Immediate	Focus Group B	• Moderator: Fair enough, but do you think that by spending more time through the LSP development of the research lessons… do you think that this has the potential for improving your students' achievement? Or not? Raymond: I think the potential [for improving student achievement] is there… yes. It's a wait-and-see thing right now. It takes time; you have to do it over time. Because this one lesson—one or two a year—you need to have more lessons already put together to address those areas that are usually difficult for students on tests. Producing these types of results will take time. You're changing the way we teach, they learn … we're all being more critical and going through things with a fine-toothed comb.

The following table lists the categories which emerged from the teachers' responses to the questions or through dialogue with each other that dealt specifically with Lesson Study impacting their students' achievement.

Table 27: Categories of Qualitative Responses to Research Question #3: Student Achievement

Categories	**Frequency of Idea Units**
Conceptual Understanding	7.41% (12 of 162)
Planning	6.79% (11 of 162)
Observation	1.23% (2 of 162)
Assessment	1.23% (2 of 162)
Affirmation	0.62% (1 of 162)
Not Immediate	0.62% (1 of 162)
TOTAL	17.90% (29 of 162)

Conceptual Understanding

Twelve of the total responses relating specifically to the research questions of this study indicated that teachers believed that students gained a more conceptual understanding of the mathematics content as a result of the Lesson Study Process. The following responses were given by teachers on the survey question regarding student achievement (Survey Question #13):

Teacher #1: "I feel my students have a much better concept and understanding of what I'm teaching [during the Lesson Study Process]."

Teacher #2: "I think that the lesson study I did with my students helped them to comprehend the content more conceptually. The students really enjoyed the lesson."

Teacher #3: "The research lesson promoted higher achievement skills through a more conceptual learning."

Teacher #4: "The students may not realize it, but [the Lesson Study Process] has really helped them become independent thinkers and problem solvers."

During the focus group sessions, the teachers responded similarly—that through the Lesson Study Process teachers have become increasingly aware of allowing the students to be able to construct their own knowledge rather than having the teacher stand in front of the classroom and teach the students through direct, rote instruction. A tenet of the Lesson Study Process is the constructivist approach to teaching—where students learn more conceptually when they are able to construct their own understanding. In the final focus group session, Lori said:

> It's about allowing them the freedom to be able to interact with each other about ideas and that they don't have to sit in a desk and just pay attention to what you're saying or what's just coming out of your mouth through direct instruction. It's giving them open-ended questions so that you can say, "Now talk to your group about this," and see what they can come up with. Believe it or not they actually do discuss what you've asked them to discuss and use the manipulatives themselves without me really having to say much where in the past I would have normally said, "Now today we're going to learn

blah-blah-blah and construct blah-blah-blah with manipulatives." They'll surprise you with what they're able to construct by working with each other.

According to several teachers in this study, by allowing students to work together in groups and use manipulatives where appropriate, students have the opportunity to construct a more conceptual understanding of the lessons being presented than through other means of teaching them. According to these teachers, the Lesson Study Process has opened their eyes to allowing students the freedom to understand mathematics lessons more conceptually through social constructivism.

In short, these teachers said that student achievement is being positively impacted by the conceptual understanding that is resulting from the teachers' participation in the Lesson Study Process. By working collaboratively with the other students and the teacher, these teachers believed that their students' achievement is increasing because of their conceptual understanding that results from the teachers' thrust for independent thinking—as opposed to being "taught" everything—and from an environment where the students are encouraged to construct new knowledge with each other thus promoting a deeper, more conceptual understanding of the lesson.

Planning

Closely related to the previous theme is the notion that teachers feel that student achievement has been improved through the planning that Research Lessons require in the Lesson Study Process. Extensive planning goes into each of the Research Lessons and, as mentioned in previous sections, is done collaboratively with other teachers. One teacher responded to one of the survey questions by saying, "The students are being presented with a

lesson that has been created through extensive planning by more than one teacher. This can only benefit their learning." A necessary part of the lesson planning is the anticipation of student questions that teachers must plan for. One teacher commented that through the Lesson Study Process "the students get a richer and more definite instruction where a lot of questions are answered for the teacher before it is presented to the students."

Lastly, teachers believed that since they are using standardized test scores to determine which lessons should be focused on—the ones that student have traditionally had the most difficulty with—student achievement will increase since extra care is taken in the development of these Research Lessons. Brenda said:

> We look at [state-specific standardized test scores], we interview teachers, we come to the conclusion that *x* was a skill across the board that needed more attention to bring up the scores in that area, to affect student learning. So we researched that, we got all of our scores from the principal, we went through the strands of the comprehensive curriculum, and isolated specifically which topics in measurement needed more improved instruction to help improve the grade.

In essence, these teachers believed that students' achievement was increasing because of the collaborative effort of planning Research Lessons that is an inherent part of the Lesson Study Process.

Other Categories

Lastly, there were several categories that emerged from the data, but that do not warrant mentioning specifically since their frequency of discussion were significantly lower than the

aforementioned themes: Observation, assessment, affirmation, and that the student achievement would not be realized immediately. Each of these categories is listed below.

Two of the teachers in this study believed that the observation part of Lesson Study positively contributes to student achievement. One teacher said, "During the observation we're focusing on the kids. We're interested in noting how they're learning and how to better teach them rather than focusing on the teacher's performance." While the presentation of the lesson is also a part of the Research Lesson observation, the student understanding of the lesson is what is most important.

The second minor theme emerging from this data set related to student achievement is the assessment aspect of a Research Lesson. Teachers are increasingly looking at how students think rather than looking at their final answer to a given problem. No one would argue that arriving at a correct answer is important. But these teachers believe that the process the students use for arriving at their answers is of equal value. Without considering the process, the teacher may be overlooking questions such as whether or not the student understood how to work the problem rather than guessing. In one of the focus groups, one of the teachers said:

> Looking at the students' learning process has made me more aware of how the students think. I'm no longer *mainly* interested in whether or not the students' answers are right or wrong, but how they processed their answer. By having them teach me their ways of doing things, I learn from them but it also helps me identify when students aren't processing the problems correctly and I can go back and correct their misconceptions rather than just assuming that they know what they're doing since they got the questions correct. Sometimes they think that they can do all of the problems, but they can't. They

> memorize something that looks like a rule that I should use to make it easier—a shortcut—and they get the question wrong, and then I have to try to undo the damage.

Understanding the students' processes of working the problem ensures that the students have worked the problems correctly and can potentially cut down on points lost if the student works the problem correctly but makes a careless error thus giving partial credit. It also saves the teacher from having to go back and have students unlearn things that they learned incorrectly and then re-teach them a correct method of working.

One of the teachers in this study gave a one-word affirmative answer on the survey, indicating that s/he believes that the Lesson Study Process improves student achievement. However, in an open forum, such as a focus group session, richer data could have been collected rather than a one-word answer.

Lastly, one teacher answered that s/he believed that student achievement could not yet be measured until after the students had been exposed to more Research Lessons—that being taught one Research Lesson is not enough to impact overall student achievement. The following statement was made during one of the focus group sessions:

> I think the potential [for improving student achievement] is there… yes. It's a wait-and-see thing right now. It takes time; you have to do it over time. Because this one lesson—one or two a year—you need to have more lessons already put together to address those areas that are usually difficult for students on tests. Producing these types of results will take time.

In summary of this research question, the perspectives of the teachers are that their students' achievement is indeed increasing as a result of the Lesson Study Process. Further, these teachers believe that their students are achieving because of: the Research Lessons; the

planning that goes into the Research Lesson development and the focus shift to the students' process of working through the problems, their students' achievement is increasing; and shift in assessment—both informal and formal—away from correct/incorrect answers to the process the students went through to arrive at their answer aids in improving student achievement.

Chapter Conclusion

As Lesson Study develops in more schools and districts, the number of Research Lessons being taught will increase, thus more students will be exposed to more research-based lessons. Because of the publication component of the Lesson Study Process, these lessons will live on long after his/her retirement. Thus, because of the Lesson Study Process, teachers will no longer have to begin planning a lesson with a blank sheet of paper but will have others' Research Lessons to modify to fit their particular classroom setting.

It is clear from the data collected in this study that the teachers believe that Lesson Study improved their mathematics content and pedagogical knowledge and has the potential for improving student achievement. On a 4.0 scale, the teachers believe that Lesson Study positively affects their content knowledge, pedagogical knowledge, and student achievement as the grand means of each of the three categories were around 3.5. Additionally, data collected for the qualitative portion of the study give evidence that the teachers responded that participating in the Lesson Study Process improved their teaching and potential for student achievement. In summary, the teachers participating in this study believe through quantitative and qualitative responses that the Lesson Study Process is an effective form of teacher professional development.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Introduction

The final chapter of this dissertation includes a summary of the purpose, research methods, procedure, data analysis, the findings of the study, and comparison of the study to previous research. The chapter concludes with considerations for further study.

Purpose of the Study and Research Questions

The purpose of this study was to investigate whether teachers believe that their content knowledge, pedagogical knowledge, and student achievement are affected by participating in the Lesson Study Process. In order to accomplish the purpose, the following research questions guided this study:

1. What are the perspectives of teachers on the impact of the Lesson Study Process on their mathematical content knowledge?
2. What are the perspectives of teachers on the impact of the Lesson Study Process on their pedagogical knowledge?
3. What are the perspectives of teachers on the potential impact of the Lesson Study Process on their students' achievement?

Methods, Procedures, Data Analysis, and Summary of Findings

The research questions driving this study called for a quasi-mixed-method, concurrent triangulation design employing both qualitative (primary) and quantitative (secondary) means of

data collection and analysis. Within the QUAL-quan framework, a case study strategy of inquiry was followed to explore in depth the questions presented by the instruments over two sequential, one-year Lesson Study cycles.

During the summer institutes, teachers formed teams grouped by the schools they represented and began developing the Research Lessons. Once returning to their respective schools in the fall, they began implementing the process in their classrooms by working with each other in the development and teaching of two Research Lessons per academic year.

This study used focus group sessions, a mostly quantitative survey, and an entirely qualitative questionnaire for collecting data. At the end of each of two summer institutes, a focus group session ("A") was held where the teachers were asked to discuss their perspectives of the Lesson Study Process as it relates to their content knowledge, pedagogical knowledge, and student achievement. During the fall semester of each year, a survey was completed by the participants after they had implemented the first Research Lesson in their schools. At the end of the second year, a second focus group session ("B") was held to probe deeper into the teachers' perspectives of Lesson Study as they relate to this study. Finally, a questionnaire was given to the teachers during the spring semesters. Participation in each of the research instruments in the study was completely voluntary.

Data analysis consisted of both quantitative and qualitative techniques. The questions on each of the instruments were segregated based on which research question each sought to answer by three other researchers and me. Once a consensus of correlation between the instruments' questions and the research questions was made, the analysis began.

Because the quantitative section of the survey was built using Likert scales, the data was analyzed using simple descriptive statistics. The mean scores of each of the questions were

calculated and a grand mean score was found for each of this study's research questions. Finally, the grand mean values, all greater than 3.4 on a 4.0 scale indicated that the teachers believed that the Lesson Study Process does positively affect their content knowledge, pedagogical knowledge, and student achievement.

A qualitative analysis examined the responses given by the teachers through surveys, questionnaires, and focus group sessions. Once the data was segregated according to which research question the instrument question answered, I began reading the responses in the interest of noting categories or themes emerging from the data. After my analysis was complete, I asked another doctoral candidate in mathematics education to perform the same analysis. We discussed any discrepancies with the two analyses and a consensus was reached.

As with the quantitative analysis, the qualitative analysis revealed that the teachers believe that their content knowledge, pedagogical knowledge, and students' achievement were positively affected by the Lesson Study Process. In fact, qualitative data echoes the findings of the quantitative results in the ranking of positive affect of Lesson Study: Pedagogical knowledge ranked first, student achievement second, and content knowledge third. The quantitative ranking is based on the grand mean score; the qualitative ranking is based on the number of responses per research question.

In the Design section of Chapter Three, I discussed the purpose of concurrent triangulation design: To concurrently collect two types of data—qualitative and quantitative—and discuss whether they converged or diverged. Also in that section I also graphically represented three instruments used for collecting the data with a triangle whose centroid was the qualitative and quantitative data. The data collected through the three instruments agreed that teachers participating in this study believe that their content knowledge, pedagogical knowledge,

and their students' achievement are improving as a result of their participation in the Lesson Study Process. Although inherent in this centroid since the data from all three instruments' agreed, it deserves mentioning that the qualitative and quantitative data types also agreed—which is typically the goal of a researcher conducting a mixed methods study (although divergence would certainly give cause for further investigation).

Findings and Current Research

Content Knowledge

Since Yoshida's (1999) study, researchers have discussed the nature of Lesson Study and its implications as a form of teacher professional development in the United States and have now begun to unfold teachers' perceptions and perspectives toward Lesson Study. The current study continues the investigation of teachers' perspectives on their teaching—including both content and pedagogical knowledge—and student achievement. Both the qualitative and quantitative findings indicate that the teachers believe that participating in the Lesson Study Process positively affects all three. With regard to their content knowledge, research participants in this study indicated that they have gained a deeper understanding of mathematics content by learning new methods of working problems and that through working with teachers from their own and other grade levels, their confidence in their knowledge of math has increased.

The findings of this study support each of the dissertations discussed in the literature review support the findings of this study. In specific, Meyer (2006) found that two out of three case studies conducted found that the middle school teachers believed that their content knowledge increased from collaborating with other teachers participating in the Lesson Study Process. Sitton (2006) found that teachers were satisfied with the impacts Lesson Study has on

their content knowledge. Finally, Mitcheltree (2006) concluded that the teachers' believed that their content knowledge was improving during each of the stages in the Lesson Study Process.

Pedagogical Knowledge

The teachers in this study indicated that their pedagogical knowledge has increased as a result of participating in the Lesson Study Process. Specifically, they indicated that their ability to plan lessons more effectively increased by planning lessons better situated within the compressive curriculum, by learning more effective ways of planning with the use of manipulatives in their classrooms, by planning lessons are relevant to their students' daily lives thereby increasing their interest in the subject, and finally by integrating literacy into the lessons as prescribed by NCTM. Teachers also reported that the collaborative aspect of the Lesson Study Process increased their pedagogical knowledge as they planned lessons with other teachers. These teachers included the importance of collaborating with teachers between and across grade levels in order to best enhance their learning and student achievement.

The teachers in this study also indicated that their confidence in teaching improved from working within the Lesson Study paradigm. Additionally, they reported that their teaching skills improved because working in the Lesson Study Process focused their attention more on how students' work through mathematics exercises rather than on assessing whether or not a student's final answer was correct. Finally, the teachers indicated that the dissemination aspect of Lesson Study will improve teaching for all teachers inasmuch as they will have the benefit of using a Research Lesson rather than having to create a new lesson on the same topic from scratch.

Similar to the question of content knowledge, each of the dissertations discussed in the literature review support the findings of this study regarding pedagogical knowledge. Meyer

(2006) found that teachers felt that their pedagogical knowledge was improving as a result of increased self-reflection, planning, and collaboration inherent in the Lesson Study Process. Sitton (2006) concluded that the teachers in her study were pleased with the effectiveness that Lesson Study has as a form of teacher professional development. Finally, Mitcheltree (2006) reported that the teachers in her study believed that their pedagogical knowledge was increasing as a result of better planning, assessment, and collaboration.

This study supports the conclusions found in the dissertations written by Meyer (2006), Sitton (2006), and Mitcheltree (2006). The teachers participating in this study reported that their students' achievement is increasing as a result of their participation in the Lesson Study Process. Specifically, they indicated that student achievement is positively affected inasmuch as their conceptual understanding of mathematics improved from being taught a Research Lesson. Additionally, they believed that the planning, observation, and assessment practices inherent in this process positively affect student achievement.

Student Achievement

Of the studies discussed in chapter two, only one dissertation focused on student achievement. Similar to this study, Meyer (2006) concluded that at the end of one Lesson Study cycle, there is limited increase in student achievement. Also similar to this study, she goes on to caution when generalizing an impact on student achievement although there is evidence to support that students are highly engaged during the presentation of research lessons.

The teachers in this study also said that since the Research Lessons were extensively planned by three or more teachers, they were able to pool their pedagogical and content knowledge thereby learning new strategies of teaching the students from a more conceptual

understanding perspective, perhaps including multiple representations of the same content. Second, they stated that unlike many observations that go on in schools today, the focus of an observation in the Lesson Study paradigm is the students' receptivity to what is being taught—whether they develop a conceptual understanding of what is being taught or merely memorizing and applying a rule.

While one teacher in this study said that the positive effects of the Lesson Study Process could not be realized immediately in student achievement, the other participants believed that students would benefit from an increased level of teacher content and pedagogical knowledge. This notion is consistent with Stigler and Hiebert (1999) who suggested that the best way to enhance student achievement is to improve the quality of teaching in classrooms. It is therefore necessary, according to Stigler and Hiebert (1999), to continually seek out means of better improving teaching in order to promote better student achievement. In summary, the results of this study indicated that the research participants believed that the Lesson Study Process is a positive force in improving their content knowledge, pedagogical knowledge, and student achievement (Lott, 2006).

Summary

The results of this study complement the findings in similar studies conducted by Sitton (2006), Meyer (2006), Mitcheltree (2006), and Lott (2006) on the Lesson Study Process. Each of these studies, including this current study, measured one or more aspects of the effects of Lesson Study on teachers' content knowledge, pedagogical knowledge, or student achievement. All concluded that teachers' believed that Lesson Study improved one or more of these three facets, depending on the perspective under study.

Although participation in this study was strictly voluntary, the teachers in this study were required to participate in the Lesson Study Process as part of a teacher professional development institute. The findings from this study contribute to the body of research in this area by showing that even when Lesson Study practices are mandated, teachers believe in its effectiveness in improving their teaching and student achievement.

Considerations for Future Research

Inasmuch as the studies discussed in the literature informed this research, the results emerging from this study give rise to the need for future research. This study contributes to the current body of research from both qualitative and quantitative means and suggests the following considerations for future research:

1. In order to better enhance the quantitative findings from this study, a larger sample size could be used to better utilize the statistical procedures that were attempted but were found to be lacking due to this study's insufficient sample size. As discussed in chapter four, a larger *n* would have increased the chances of a statistical factor analysis of the survey data. The presence of this statistic would be valuable for enhancing the reliability of the instrument.
2. Research considerations should include an experimental study focusing on student achievement. Although there are many variables to control when designing a study based on student achievement, there are feasible strategies. One such study might include two classrooms of students with comparable math background. Both groups could be given a pretest and posttest while one group would be given the Research Lesson treatment with the control group receiving normal instruction from their teacher. After the treatment, a comparison of the test scores could be analyzed and discussed.

3. Each of the teachers in this study was a part of a teacher professional development institute. Comparing the results from this study with one from a school or district where Lesson Study is one of the adopted forms of teacher professional development could increase the body of knowledge regarding the motivation for participating in the Lesson Study Process and the teachers' views of its effectiveness in their classrooms.

4. Another consideration would be the effects that buy-in from administrators play in the Lesson Study Process. The teachers in this and other studies indicated that administrative buy-in is critical inasmuch as it is one of the determinants in the availability of time needed for the Lesson Study Process. Comparing the perspectives of the teachers' whose principals allow them the resources needed to fully immerse themselves in the Lesson Study Process versus those who do not, would increase the body of knowledge regarding the necessity of administrative buy-in for successful implementation of the Lesson Study Process.

5. Researchers from other subjects such as science and English are beginning to participate in Lesson Study. These Lesson Study environments, as well as those which are taking place up to the university level, are ripe for research in this field. Extending studies such as these to other grade levels and content areas would benefit the body of knowledge pertaining to the Lesson Study Process.

Summary of Study

Additional research on the Lesson Study Process employing both quantitative and qualitative methodology will offer more comprehensive understanding of the effects of Lesson Study on student achievement. Improving teachers' content and pedagogical knowledge is certainly an aim of the Lesson Study Process but is not a goal in itself; it is the means for arriving

at the major goal of fostering teacher collaboration. One of the teachers responded to a survey question with the following statement:

> The Lesson Study Process helps teachers to prepare and present a more seasoned lesson that is rich with fun and engaging activities. Student and teachers alike have math phobias but tend to shy away because the lesson is not engaging or it is presented is such a way that it loses them at the onset. The Lesson Study Process helped me to get over some of my uneasiness about math, therefore, I am more confident in my delivery of mathematical concepts.

Implicit in this comment is the help of colleagues to lessen mathematics anxiety. Indeed the goal of any method of teacher professional development is to ignite something within the teacher that enhances his or her ability to more effectively teach his/her students and to allow students to construct more conceptual understanding of the material being taught. Teachers participating in this study report that the Lesson Study Process is helpful to accomplishing that goal. Forsooth the teachers in this study believe unreservedly that their content knowledge, pedagogical knowledge, and students' achievement have been positively affected by the Lesson Study Process.

REFERENCES

American Recovery and Reinvestment Act (ARRA). (2009). Retrieved March 17, 2009 from http://frwebgate.access.gpo.gov/cgibin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf

Baird, F. E., & Kaufmann, W. (2003). *Ancient philosophy*. Upper Saddle River, NJ: Prentice Hall.

Banks, J. (2005). *Discrete-event system simulation*. Upper Saddle River, NJ: Prentice Hall.

Bereiter, C. Constructivism, socioculturalism, and Popper world 3. *Educational Researcher, 23*(7), 21-23.

Blais, D. M. (1988). Constructivism – a theoretical revolution for algebra. *Mathematics Teacher, 81*(11), 624-631.

Blase, J. (2000). Forward to Vicky R. Husby's *Individualizing Professional Development*. Thousand Oaks, CA: Corwin Press, Inc.

Bogdan, R., & Taylor, S. J. (1975). *Introduction to qualitative research methods*. New York, NY: John Wiley.

Boisvert, R. D. (1998). *John Dewey: Rethinking our time.* Albany, NY: State University of New York Press.

Boudourides, M. A. (1998, July). Constructivism and education: A shopper's guide. Contributed paper at the International Conference on the *Teaching of Mathematics*.

Brewer, M. (2000). Research Designs and Issues of Validity. In Reis, H., and Judd, C. (Eds.) *Handbook of Research Methods Social and Personality Psychology.* Cambridge, MA: Cambridge University Press.

Bruner, J. (1959). *The process of education*. Cambridge, MA: Harvard University Press.

Bruner, J. (1996). *The culture of education.* Cambridge, MA: Harvard University Press.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental design for research*. Boston, MA: Houghton Mifflin Company.

Chenoweth, K. (2000, December 21). Homeroom. *Montgomery Extra*. Rockville, MD.

Chokshi, S. (2004). "Timeline of U.S. Lesson Study," compiled for NAS/NRC's Board on International Comparative Studies in Education commissioned report, "Impact of Lesson Study." Retrieved January 25, 2008, from http://www.tc.edu/lessonstudy/timeline.html

Chokshi, S., & Fernandez, C. (2004). "Challenges to importing Japanese lesson study: Concerns, misconceptions and nuances," *Phi Delta Kappan, 85*(7), 520-525.

Chomsky, N. (1968). *Language and mind*. New York: Harcourt Brace Jovanovich.

Choy, S. P., X. Chen, & Bugarin, R. (2006). *Teacher professional development in 1999-2000.* Jessup, MD: National Center for Education Statistics.

Clements, D. H., & McMillen, S. (1996, January). "Rethinking 'concrete'manipulatives." *Teaching Children Mathematics (2)*. 270-279.

Cobb, P., & Bauersfeld, H. (1995). *The emergence of mathematical meaning: Interaction in classroom cultures*. Hillsdale, NJ: L. Erlbaum Associates.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Education Psychologist*, *31*(4), 175-190.

Cole, M., & Wertsch J. V. (2002). *Beyond the individual-social antimony in discussions of Piaget and Vygotsky*. Alton, Hampshire, England: Prometheus Research Group.

Confrey, J. (1990). What constructivism implies for teaching. In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 107-122). Reston, VA: National Council of Teachers of Mathematics.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods Approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Thousand Oaks, CA: Sage Publications.

Curcio, F. (2002). *A user's guide to Japanese lesson study: Ideas for improving mathematics teaching*. Reston, VA: National Council of Teachers of Mathematics.

Daniels, H. (Ed.) (1996). *An introduction to Vygotsky*. London, England: Routledge.

Darling-Hammond, L. (1998). Teacher learning that supports student learning. *Educational Leadership*, *55*(5), 6-11. Alexandria, VA: ASCD.

Darling-Hammond, L., & McLaughlin, M. W. (1999). Investing in teaching as a learning profession: Policy problems and prospects. In *Teaching as the learning profession: Handbook of policy and practice*. San Francisco, CA: Jossey-Bass.

Davis, R. B. (1990). Discovery learning and constructivism. In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 93-106). Reston, VA: National Council of Teachers of Mathematics.

Davis, R. B., & Maher, C. A. (1990). The nature of mathematics: What do we do when we "do mathematics"? In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 65-78). Reston, VA: National Council of Teachers of Mathematics.

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage handbook of qualitative research*. Thousand Oaks, CA: Sage Publications, Inc.

Dewey, J. (1909). *Moral principles in education.* Boston, MA: Houghton Mifflin.

Dewey, J. (1916). *Democracy and Education.* Boston, MA: Houghton Mifflin.

Dewey, J. (1938). *Experience and education*. New York, NY: Collier.

Dickson, P. (2001). *Sputnik: The shock of the century*. New York, NY: Walker & Company.

Dossey, J. A. (1992). The nature of mathematics: Its role and its influence. In Douglas A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp. 39-48). New York, NY: The Macmillan Company.

Fennell, F. (2008). "What algebra? When?" *NCTM News Bulletin*, *44*(6). Reston, VA: National Council of Teachers of Mathematics.

Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53*(5), 390-405.

Fernandez, C., Cannon, J., & Chokshi, S. (2003). A U.S.-Japan lesson study collaboration reveals critical lenses for examining practice. *Teaching and Teacher Education, 19*(2), 171-185.

Fernandez, C. (2007). Lesson Study Research. Retrieved November 30, 2007, from http://www.tc.edu/lessonstudy/research.html

Fiszer, E. P. (2004). *How teacher learn best: An ongoing professional development model*. Lanham, MD: ScarecrowEducation.

Fleury, S. C. (1998). Social studies, trivial constructivism, and the politics of social knowledge. In M. Larochelle, N. Bednarz, & J. Garrison (Eds.), *Constructivism and Education*. Cambridge, UK: Cambridge University Press.

Fosnot, C. T. (1996). *Constructivism: Theory, perspectives, and practice*. New York, NY: Teachers College Press.

Frame, D. M. (1969). *Montaigne's Essais: A study.* Upper Saddle River, NJ: Prentice-Hall, Inc.

Freppon, P. A. (2001). *What it takes to be a teacher: The role of personal and professional development*. Portsmouth, NH: Heinemann.

Gay, L. R., Mills, G. E., & Airasian, P. (2006). *Educational research: Competencies for analysis and applications*. Upper Saddle River, NJ: Pearson.

Geist, E. (2009). *Children are born mathematicians: Supporting mathematical development, birth to age 8*. Pearson: Upper Saddle River, NJ.

Gergen, K. J. (1995). Social construction and the educational process. In L. P. Sfeffe & J. Gale, *Constructivism in education* (pp. 17-39). Hillsdale, NJ: Erlbaum.

Germain-McCarthy, Y. (2001). *Bringing the NCTM standards to life.* Larchmont, NY: Eye on Education.

Gianturco, E. (1965). (Translator) of Giambattista Vico, *On the Study Methods of Our Time*. New York: Bobbs-Merrill.

Glaser, B. G. (1978). *Theoretical sensitivity*. Mill Valley, CA: Sociology Press.

Glaser , B. G., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York, NY: Aldine.

Glesne, C. (1999). *Becoming qualitative researchers: An introduction*. New York, NY: Longman.

Goldin, G. A. (1990). Epistemology, constructivism, and discovery learning mathematics. In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 31-47). Reston, VA: National Council of Teachers of Mathematics.

Goldman, S. L. (2006). *Science wars: What scientists know and how they know it* [Audio version]. Chantilly, VA: The Teaching Company.

Gordon, S. P. (2000, November). *Professional development for teacher and school renewal: Alternative pathways, common characteristics*. Paper presented at the University Council for Educational Administration Annual Convention, Albuquerque.

Gordon, S. P. (2004). *Professional development for school improvement: Empowering learning communities*. Upper Saddle River, NJ: Pearson Education, Inc.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a conceptual framework for mixed method evaluation designs. *Educational Evaluation and Policy Analysis, 11*(3), 255-274.

Guba, E. G., & Lincoln, Y. S. (1981). *Effective evaluation*. San Francisco, CA: Jossey-Bass Publishers.

Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin Press, Inc.

Hartnack, J. (1974). *Immanuel Kant: An explanation of his theory of knowledge and moral philosophy*. Atlantic Highlands, NJ: Humanities Press.

Hatfield, M. M., Edwards, N. T., & Bitter, G. G. (1999). *Mathematics methods for elementary and middle school teachers*. New York, NY: John Wiley & Sons, Inc.

Husby, V. R. (2005). *Individualizing professional development*: *A framework for meeting school and district goals.* Thousand Oaks, CA: Corwin Press, Inc.

Isoda, M., Stephens, M., Ohara, Y., & Miyakawa, T. (Eds.) (2007). *Japanese lesson study in mathematics: Its impact, diversity, and potential for educational development*. Hackensack, NJ: World Scientific Publishing Co.

Jick, T. D. (1979, December). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly, 24*, 602-611.

Jonassen, D. H. (1990). Thinking technology. Toward a constructivist view of instructional design. *Educational technology, 30* (9), 32-34.

Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). *Learning with technology: A constructivist perspective*. Upper Saddle River, NJ: Prentice Hall, Inc.

Leitzel, J. R. (Ed.) (1991). *A call for change: Recommendations for the mathematical preparation of teachers of mathematics* (An MAA Report by The Mathematical Association of America, Committee on the Mathematical Education of Teachers).

Lewis, C. (2000, April). *Lesson study: The core of Japanese professional development.* Paper prepared for the American Research Association Meeting, New Orleans, LA.

Lewis, C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia, PA: Research for Better Schools, Inc.

Lewis, C. (2002, January). Does lesson study have a future in the United States? Nagoya, Japan: *Nagoya Journal of Education and Human Development*, 1, pp. 1-23.

Lewis, C., & Tsuchida, I. (1997). Planned educational change in Japan: The case of elementary science instruction. *Journal of Educational Policy, 12*(5), 313-331.

Lewis, C., & Tsuchida, I. (1998, Winter). A lesson is like a swiftly flowing river: Research lessons and the improvement of Japanese education. *American Educator*, 14-17, 50-52.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage Publications.

Little, J. W. (1999). Organizing schools for teacher learning. In *Teaching as the learning profession: Handbook of policy and practice*. San Francisco, CA: Jossey-Bass.

Lochhead, J. (1985). Introduction to section I: New horizons in educational development. *Review of Research in Education, 12,* 3-9.

Lott, J. G. (2006). *Teachers' perceptions of the effectiveness of the Lesson Study Process in improving teaching and student learning.* Unpublished undergraduate honors thesis, University of New Orleans.

Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P.W. (2003). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press.

Magestro, P. V., & Stanford-Blair, N. (2000). A tool for meaningful staff development. *Educational Leadership, 57*(8), pp. 34-35. Alexandria, VA: Association for Supervision and Curriculum Development.

Maher, C.A., & Alston, A. (1990). Teacher development in mathematics in a constructivist framework. In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 147-165) Reston, VA: National Council of Teachers of Mathematics.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey-Bass Publishers.

Meyer, R. D. (2006). *Lesson study: The effects on teachers and students in urban middle schools*. Unpublished doctoral dissertation, Baylor University.

Mikusa, M. G., & Lewellen, H. (1999). Now here is that authority on mathematics reform, Dr. Constructivist. *The Mathematics Teacher, 92*(2), 158-163.

Miles, M. B. (1995). Forward. In T. R. Guskey & M. Huberman (Eds.), *Professional development in education: New paradigms and practices* (pp. vii-ix). New York, NY: Teachers College Press.

Miller, B., Moon, J., & Elko, S. (2000). *Teacher leadership in mathematics and science*. Portsmouth, NH: Heinemann.

Mitchelltree, M. K. (2006). *Exploring lesson study as a form of professional development for enriching teacher knowledge and classroom practices*. Unpublished doctoral dissertation, University of New Hampshire.

Morgan, D. L. (1988). *Focus groups as qualitative research*. Newbusy Park, CA: Sage Publications.

National Center for Education Statistics. (2007). *The nation's report card Mathematics 2007*. Washington, DC: U. S. Department of Education.

National Commission on Excellence in Education, The. (1983, April). *A nation at risk: The imperative for education reform*. An open letter to the American people. Retrieved November 17, 2007, from http://www.air.org/publications/documents/phillips.chance.favors.the.prepared.mind.pdf

National Commission on Excellence in Education, The American Institutes for Research. (2007, November). 8th graders in most U.S. states performing better in math and science than students in most foreign countries [News release] [Electronic version]. Retrieved November 15, 2007, from http://www.air.org/news/pr/8thGrader.aspx

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston , VA: The National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston , VA: The National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2008). NCTM Lesson Study Course. Retrieved January 8, 2008 from http://www.nctm.org/lessonstudy.aspx

National Education Goals Panel (NEGP). (2000). *National Education Goals Report*. Washington, DC: NEGP.

National Public Radio. (2007). *Sputnik left legacy for U.S. science education.* Retrieved November 18, 2007, from http://www.npr.org/templates/story/story.php?storyId=14829195

National Research Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education*. Washington, DC: National Academy Press.

National Research Council. (2002). *Studying classroom teaching as a medium for professional development*. Proceedings of a U. S. – Japan Workshop. Washington, DC: National Academy Press.

Noddings, N. (1990). Constructivism in mathematics education. In R. B. Davis, C. A. Maher, & N. Noddings (Eds.), *Constructivist Views on the Teaching and Learning of Mathematics* (pp. 7-18). Reston, VA: National Council of Teachers of Mathematics.

Olssen, M. (1996). Radical constructivism and its failings: Anti-realism and individualism. *British Journal of Educational Studies, 44*(3), 275-295.

Ornstein, A. C., & Hunkins, F. P. (1988). *Curriculum: Foundations, principles, and issues.* Edgewood cliffs, NJ: Prentice Hall.

Orton, R. E. (1995). Ockham's razor and Plato's beard (Or, "The possible relevance of the philosophy of mathematics, and the problem of universals in particular, to the philosophy of mathematics education, and the problem of constructivism in particular"). *Journal for Research in Mathematics Education, 26, 3,* 204-229.

Peshkin, A. (1990). In search of subjectivity-One's own. *Educational Researcher, 17* (7), 17-22.

Phillips, D. C. (Ed.). (2000a). *Constructivism in education Opinions and second opinions on controversial issues*. Chicago, IL: The University of Chicago Press.

Phillips, D. C. (2000b). *An opinionated account of the constructivist landscape*. Chicago, IL: The National Society for the Study of Education.

Phillips, G. W. (2007). *Chance favors the prepared mind: Mathematics and science indictors for comparing states and nations*. Washington, DC: American Institutes for Research.

Piaget, J. (1953). *Logic and psychology*. Manchester, England: Manchester University Press.

Piaget, J. (1963). *The psychology of intelligence*. New York, NY: Routledge.

Piaget, J. (1972). *Psychology and epistemology. Towards a theory of knowledge*. London, England: Penguin.

Piaget, J. (1973). *To understand is to invent.* New York, NY: Grossman.

Piaget, J. (1977). Forward in J-C Bringuier (Trans.) *Conversations libres avec Jean Piaget*. London, England: Routledge and Kegan Paul.

Piaget, J. (1978). Intellectual operations and their development. In H. E. Grueber & J. J. Voneche (Eds.), *The Essential Piaget* (pp. 342-358). New York, NY: Basic Books.

Piaget, J. (1985). *Equilibrium of cognitive structures: The central problem of intellectual development.* Chicago, IL: University of Chicago.

Pinar, W. F. (2004). *What is curriculum theory?* Mahwah, NJ: Erlbaum Associates.

Pirie, S., & Kieren, T. (1992). Creating constructivist environments and constructing creative mathematics. *Educational Studies in Mathematics, 23,* 505-528.

point of view. (2008). In *Merriam-Webster Online Dictionary*. Retrieved November 11, 2008, from http://www.merriam-webster.com/dictionary/point of view

Polya, G. (1963). On Learning, teaching, and learning teaching. *The American Mathematical Monthly, 70*(6), 605-619.

Post, G., & Varoz, S. (2008, April). Lesson study groups with prospective and practicing teachers. *Teaching Children Mathematics*. Reston, VA: NCTM.

Prevost, F. J. (1993). Rethinking how we teach: Learning mathematical pedagogy. *Mathematics Teacher, 86*(1), 75-79.

Programme for International Student Assessment (PISA). (2006). Science competencies for tomorrow's world. Paris, France: Organisation for Economic Co-operational and Development.

Reys, R. E., Lindquist, M. M., Lambdin, D. V., & Smith, N. L. (2007). *Helping children learn mathematics*. Hoboken, NJ: John Wiley & Sons, Inc.

Richards, J., & von Glasersfeld, E. (1980). Jean Piaget, psychologist of epistemology: A discussion of Rotman's Jean Piaget: Psychologist of the real. *Journal for Research in Mathematics Education, 11*(1), 29-36.

Richardson, J. (2000). *Lesson study: Japanese method benefits all teachers*. Oxford, OH: National Staff Development Council. Retrieved January 29, 2008, from http://www.nsdc.org/library/publications/results/res12-00rich.cfm

Riegler, A. (2003). *The key to radical constructivism*. Retrieved November 18, 2007, from http://www.univie.ac.at/constructivism/key.html

Rock, T. C., & Wilson, C. (2005, Winter). Improving teaching through lesson study. *Teacher Education Quarterly*. Stockton, CA: Caddo Gap Press.

Romberg, T. A. (1990). Evidence which supports NCTM's curriculum and evaluation standards for school mathematics. *School science and mathematics, 90*(6), 466-479.

Rossman, G. B., & Wilson, B. L. (1985). Numbers and words: Combining quantitative and qualitative methods in a single large-scale evaluation study. *Evaluation Review, 9*(5), 627-643.

Ryan, G. W., & Bernard, H. R. (2003, February). Techniques to identify themes. *Field Methods, 15*(1), 85-109.

Ryan, G. W., & Bernard, H. R. (2008). Techniques to identify themes in qualitative data. Retrieved November 30, 2008 from http://www.analytictech.com/mb870/Readings/ryan-bernard_techniques_to_identify_themes_in.htm

Silver, E. A. (1998). Improving mathematics in middle school: Lessons from TIMSS and related research. Washington, DC: ED.

Simon, M. A., & Schifter, D. (1991). Towards a constructivist perspective: An intervention study of mathematics teacher development. *Educational Studies in Mathematics, 22*, 309-31.

Sitton, P. A. (2006). *The effectiveness of lesson study as a professional development model for K-5th grade teachers*. Unpublished doctoral dissertation, Capella University.

Smith, C. J. (1996). Introduction and Overview. In C. J. Smith & V. P. Varma (Eds.), *A handbook for teacher development*. Brookfield, VT: Ashgate Publishing Company.

Smith, E. (1997). Constructing the individual knower: A review of the book *Radical Constructivism*. *Journal for Research in Mathematics Education, 28*(1), 106-111.

Spradley, J. P. (1979). *The ethnographic interview*. New York, NY: Harcourt Brace Jovanovich College Publishers.

Spring, J. (1994). *The American school, 1642-1993*. New York, NY: McGraw-Hill.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications.

Steffe, L. P., & Cobb, P. (with von Glasersfeld, E.). (1988). *Construction of arithmetical meanings and strategies*. New York, NY: Springer-Verlag.

Steffe, L. P., & Kieren, T. (1994). Radical constructivism and mathematics education. *Journal for Research in Mathematics Education, 25*(6), 711-733.

Steinkraus, W. E. (1975, Sept.). A review of *Immanuel Kant: An Explanation of his Theory of Knowledge and Moral Philosophy* by Justus Hartnack in *Philosophy and Phenomenological Research, 36*(1), 140.

Stephens, W., & Romberg T. (1985). *Reconceptualizing the role of the mathematics teacher.* Paper presented at the Annual Meeting of the American Educational Research Association. Chicago.

Stevenson, H. W., & Stigler, J. W. (1992). *The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese education*. New York, NY: Simon & Schuster.

Stevenson, I. (1998). Radical constructivism by Ernst von Glasersfeld [Review]. *Educational Studies in Mathematics Education, 35*(1), 93-104.

Stiff, L. V., Johnson, J. L., & Johnson, M. R. (1993). Cognitive issues in mathematics education. In Patricia S. Wilson (Ed.), *Research Ideas for the Classroom. High School Mathematics* (pp. 3-20). New York, NY: The Macmillan Company.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap*. New York, NY: The Free Press.

Tarnas, R. (1991). *The passion of the Western mind: Understanding the ideas that have shaped our world view*. New York, NY: Ballantine Books.

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Thorndike, E. L. (1922). *The psychology of arithmetic.* New York, NY: The Macmillan Company.

Trends in International Mathematics and Science Study (TIMSS). (2004, 2008). Washington, DC: National Center for Education Statistics.

United States Department of Education (ED). (2001). *No child left behind act*. Retrieved November 18, 2007 from http://www.ed.gov/policy/elsec/leg/esea02/107-110.pdf

United States Department of Education. (2007). Overview. Retrieved November 18, 2007, from http://www.ed.gov/about/landing.jhtml?src=gu

United States Department of Education. (2008). The final report of the national mathematics advisory panel. Washington, DC: ED.

Vinovskis, M. A. (1999). *The road to Charlottesville: The 1989 education summit* [Electronic version]. Washington, DC: National Education Goals Panel. Retrieved November 20, 2007 from http://govinfo.library.unt.edu/negp/reports/negp30.pdf

Vogt, W. P. (2007). *Quantitative research methods for professionals*. Boston, MA: Pearson.

von Glasersfeld, E. (1980). After metaphysics: Toward a grammar of interaction and discourse by Harvey Sarles [Response]. *American Anthropologist, 82*(2), 409-410.

von Glasersfeld, E. (1981). An attentional model for the conceptual construction of units and number. *Journal for Research in Mathematics Education, 12*(2), 83-94.

von Glasersfeld, E. (1984). To hell with psychology: Plato, Piaget, and scientific psychology by Kieren Egan [Review]. *Journal for Research in Mathematics Education, 15*(5), 389-391.

von Glasersfeld, E. (1989). Abstraction, representation, and reflection: An interpretation of experience and Piaget's approach. In L. P. Steffe (Ed.), *Epistemological Foundations of Mathematical Experience*. Hillsdale, NJ: Erlbaum.

von Glasersfeld, E. (1990a). An exposition of constructivism: Why some like it radical. *Journal for Research in Mathematics Education* [Monograph], *4*, 19-29, 195-210.

von Glasersfeld, E. (1990b). Environment and education. In L. P. Steffe & T. Wood (Eds.), *Transforming Children's Mathematics Education: International Perspectives* (pp. 200-215). Hillsdale, NJ: Lawrence Erlbaum.

von Glasersfeld, E. (1991). Knowing without metaphysics: Aspects of the radical constructivist position. *Research and Reflexivity,* 12-29. F. Steier (Ed.). London: Sage.

von Glasersfeld, E. [Guest Editorial] (1992). Constructivist Teaching: Methods and Results. *Educational Studies in Mathematics, 23*(5) , 443-444.

von Glasersfeld, E. (1992a). Questions and answers about radical constructivism. In M. K. Pearsall (Ed.) *Scope, Sequence, and Coordination of Secondary School Science, 11,* 169-182. Washington, DC: NSTA.

von Glasersfeld, E. (1995). *Radical constructivism: A way of knowing and learning*. London: The Falmer Press.

von Glasersfeld, E. (1996). Footnotes to "The many faces of constructivism" [Response to Denis Phillip's article "The Good, the Bad, and the Ugly: The Many Faces of Constructivism"]. *Educational Researcher, 25*(6), 19.

von Glasersfeld, E. (Ed.) (2002). *Radical constructivism in mathematics education*. New York, NY: Kluwer Academic Publishers.

Vygotsky, L. S. (1962). *Thought and language*. Boston, MA: The Massachusetts Institute of Technology.

Vygotsky, L. S. (1978). *Mind in society.* Cambridge, MA: Harvard University Press.

Wang-Iverson, P. (2002). "Why lesson study?" in *Papers and Presentations: An Introduction from RBS Lesson Study Conference 2002*. Retrieved January 25, 2008, from http://www.rbs.org/lesson_study/conference/2002/papers/wang.php

Wang-Iverson, P., & Yoshida, M. (2005). *Building our understanding of lesson study*. Philadelphia, PA: Research for Better Schools, Inc.

Ward, C. D. (2001). Under construction: On becoming a constructivist in view of the *Standards*. *Mathematics Teacher, 94*(2), 94-96.

Watanabe, T. (2002). "Learning from Japanese lesson study." *Educational Leadership*, 59, 36-39.

Watanabe, T. (2003, Winter). "Lesson study: A new model of collaboration." *Academic Exchange Quarterly*, 180-184.

Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education 75*(1), 9-21.

Willoughby, S. S. (1990). *Mathematics education for a changing world*. Alexandria, VA: Association for Supervision and Curriculum Development.

Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research, 72*(2) 131-175.

The Why Files: Science Behind the News. (n.d.). *Sputnik's legacy: The U.S. response to Sputnik*. Retrieved November 18, 2007, from The University of Wisconsin, Board of Regents Web site: http://whyfiles.org/047sputnik/main2.html

Wubbels, T. (1992). Radical constructivism in mathematics education by Ernst von Glasersfeld [Review]. *Educational Studies in Mathematics, 23*(6), 619-624.

Yoshida, M. (1999). *Lesson study: An ethnographic investigation of school-based teacher development in Japan*. Doctoral Dissertation, University of Chicago.

Yoshida, M. (2002). *Lesson Study: A Japanese approach to improving the teaching and learning of mathematics*. Madison, NJ: Global Education Resources, LLC.

Zudzina, M. R. (1997). Case study as a constructivist pedagogy for teaching educational psychology. *Educational psychology review, 9*(2), 199-203.

Appendix A

Survey of Teacher Perspectives of the Effectiveness of Lesson Study in Improving Teaching and Student Achievement

THE UNIVERSITY of NEW ORLEANS

Survey of Teacher Perspectives of the Effectiveness of Lesson Study in Improving Teaching and Student Achievement

Part I: Demographics

Please respond to the following questions:

1. In what school district do you currently teach? _____ 1b. Teacher ID: _____
2. What grade level do you currently teach? _____
3. How many months have you participated in a Lesson Study? _____

Please place an X next to the response(s) that best describes you.

How many years have you taught prior to this school year? __0-2 years __3-5 years __6-10 years __11-15 years __15+ years

Educational Background: ___Teacher-Certified ___Alternatively Certified ___Applying for Certification ___Graduate Degree

Part II: Opinion

Please circle the choice that best describes your personal opinion regarding the following statements.

1. Teachers plan lessons more effectively than usual while participating in Lesson Study.	Strongly Agree	Agree	Disagree	Strongly Disagree
2. The Lesson Study Process is a good tool for teacher professional development.	Strongly Agree	Agree	Disagree	Strongly Disagree
3. I plan to continue using Lesson Study in the future.	Strongly Agree	Agree	Disagree	Strongly Disagree
4. I think Lesson Study has positively impacted students' understanding of math concepts.	Strongly Agree	Agree	Disagree	Strongly Disagree
5. I think practicing Lesson Study has positively impacted students' scores on standardized tests.	Strongly Agree	Agree	Disagree	Strongly Disagree
6. I feel more comfortable teaching lessons with observers in the classroom as a result of the Lesson Study Process.	Strongly Agree	Agree	Disagree	Strongly Disagree
7. The Lesson Study Process makes me feel more comfortable teaching math.	Strongly Agree	Agree	Disagree	Strongly Disagree
8. Participating in the Lesson Study Process has improved my knowledge of math content.	Strongly Agree	Agree	Disagree	Strongly Disagree
9. Participating in the Lesson Study Process has improved my ability to teach math.	Strongly Agree	Agree	Disagree	Strongly Disagree
10. After teaching a lesson developed by the team, I find the observers' comments and the reflection/revision process helpful.	Strongly Agree	Agree	Disagree	Strongly Disagree

continue to next page →→→

Please respond to the following questions:

11. What do you think are the advantages of the Lesson Study Process?

12. What do you think are disadvantages of the Lesson Study Process?

13. How do you think Lesson Study has affected student learning/achievement?

14. How do you think Lesson Study has affected your learning of math?

15. Other Comments:

Please rate your overall perspectives of Lesson Study in improving your teaching of math (circle):

HIGH 10 9 8 7 6 5 4 3 2 1 LOW

Please rate your overall perspectives of Lesson Study in improving your math content knowledge (circle):

HIGH 10 9 8 7 6 5 4 3 2 1 LOW

Please rate your overall perspectives of Lesson Study in improving student achievement (circle):

HIGH 10 9 8 7 6 5 4 3 2 1 LOW

Appendix B

Lesson Study Reflections Questionnaire

Lesson Study Reflections Questionnaire

Date _____ Grade_____

1. Using the UNO-Peer Teachers groups as an example of the Lesson Study Process, is your content knowledge of mathematics changing?

2. How is it changing?

3. Using the UNO-Peer Teachers groups as an example of the Lesson Study Process, are your pedagogical skills changing?

4. How are they changing?

continue to next page →→→

5. Are there any issues/problems that you foresee with Peer Teaching and the Lesson Study Process as you try it in your school?

6. What are some ideas for overcoming some of the issues/problems?

7. What are your thoughts about how Peer Teaching in your school might improve the teaching of difficult lessons?

Appendix C

Transcription of Focus Group A 2007

Moderator:	Using the Lesson Study Process, is your content knowledge of mathematics changing?
Rosetta:	Yes.
Moderator:	How is it changing?
Rosetta:	Even beyond the peer teacher lessons we've been preparing, our mathematics content knowledge is improving as a result of this workshop.
Carolyn:	Our knowledge of the grade level pre-requisites is being expanded.
Moderator:	Using the Lesson Study Process, are your pedagogical skills changing?
Sue:	Yes.
Moderator:	How is it changing?
Sue:	[Lesson Study] is teaching us to go back and look at *how* to teach the lesson.
Ashley:	By working with other teachers, we are discovering how to better use manipulatives—shows the thinking process of solving these problems.
Cinda:	Lesson Study is allowing us to see others' approach to the lessons.
Carolyn:	The Lesson Study Process is making you more aware of what you're teaching. How the manipulatives like pattern blocks are put together to make one [whole] shape.
Moderator:	Are there any issues/problems that you foresee with the Lesson Study Process as you try it in your school?
Linda:	In any school, you're going to have those who are resistant. "This is how I've been doing it all these years and it works my way." Don't force anyone to join in. Once they see it working well for others, they'll want to follow suit.
Sue:	Some will put up a road-block. They take peer observations too personally.
Kay:	Some will be unconvinced that a new way of teaching may be better.
Monroe:	The participants have to be able to work with other people.
Connie:	We'll have to show them that the Lesson Study Process is not equal to other peer coaching: it's not looking *how* you teach… we're not critiquing you or your teaching, but is only critical of the lesson, and how it's being understood by the students.
Monroe:	Have to get through the sensitivity issues.
Moderator:	What are some ideas for overcoming some of the issues/problems?
Connie:	There has to be a shift from the stigma of principal-observation—where he's grading/critiquing the teacher.
Monroe:	There needs to be training on how to phrase things so that it's not personal. "Can you try this lesson for me and see if this works for you? May I be in the class to see how students are reacting? Now we can try it on the kids because I already know what the outcome is…"
Nelda:	Some principals are always in and out. This releases the pressure of any one, specific visit from others.
Monroe:	This builds confidence in content leading to confidence in observation.
Moderator:	What are your thoughts about how Peer Teaching in the form of the Lesson Study Process in your school might improve the teaching of difficult lessons?

Rosetta: By sharing ideas, tweaking lessons the lessons *will* get better. The entire school needs to get involved. Small groups work better. Find a group that is interested in this. Then when others see it working, they will want to join in.

Moderator: Did you find the workshop valuable so far? Why?

Carolyn: Yes, especially in the geometry skills. We could use an entire workshop on how to use the manipulatives. The formal instructional books make no sense. Confidence level increases when working with each other. It helps to thinking aloud about this stuff.

Moderator: What are some suggestions for improving this workshop?

Kimberly: Time frame is great. The dates were good because they were all together, rather than having breaks in between when things will be forgotten. We started close enough after school ending to have a small break, become refreshed, but still in the mindset of working. It would be worse if we started in July.

Appendix D

Transcription of Focus Group A 2008

Moderator: Thank you all for coming; I know you're terribly busy. You've had a lot of learning since you've been here. Some of it has been from the math faculty; some of it's been from the grant project director. Obviously you've increased your content knowledge and pedagogy from being here, but you've also done lesson study, in particular, where you've worked with each other, you've collaborated on the lesson plans, and in a way, you've increased your content knowledge that way. And that's what we're really focusing on is the lesson study aspect of learning and not that other stuff. So if you can, try to separate what you've learned as a result of lesson study. That's what we're here to discuss in this focus group session: what you've learned during the Lesson Study Process.

Rosalyn: Right. And I think the whole idea of lesson study is excellent and what it brought to focus for me is the curriculum alignment because I became so aware of what a sixth grader was doing in a third grade, a fourth, and a fifth grade classroom and I think that was one of the best things for me to think about is the curriculum alignment. Our discussion of the topic was lapsed time. They need to know that foundation starting in kindergarten and up: What the third grade teacher should do to get them ready for the fourth, and so on…

Lori: <*Interrupts*> It takes you away from that closed door emphasis that teachers have always known. You're in this room, you close that door; it takes you away from that and it actually forces you to get into a collaborate effort.

Friends from the same school….interrupting each other, completing each other's sentence, etc.

Rosalyn: <*Interrupts*> You feel less isolated in what you were doing.

Lori: <*Interrupts*> To increase student achievement: you're looking, you're searching for something that needs to be focused on. Once you find that you work with a team to find a lesson that will truly impact your students in positive way… instead of teaching in that one room [motions a box w/ her hands] instead of in this little box…

Rosalyn: <*Interrupts*> … this is my GLE, this is what I'm going to do.

Lori: <*Interrupts*> …the format, of how you go about… the steps…

Caroline: <*Interrupts*> …the prerequisites you go through to get to that point.

Lori: <*Confirms*> Right.

Moderator: So what you're saying is that in-depth look that we look at … what it is we're going to teach. Not only are we looking at what we teach, but it forces us to look at the whole process. Looking at what the other people who are involved in terms of getting the kids to where we want them to be.

Brenda: The order of sequence it starts down and flows up.

Lori: So you can't just consider your little moment in time.

Sydney: And just as important I think is what you're saying about the curriculum alignment and the sequencing, is the type of culture it creates. Kind of like what you were getting at <*motions to Lori*>. At our school, the teachers I've been collaborating with—we barely talked this past year and now we've been talking so much more and even if our lesson study doesn't get off perfectly this year I know that we've built a more collaborative foundation as a school and also the … when you're observing you're focusing more on the kids and more about how they're learning rather than how you're going to teach something. And I think that that's going to be really valuable just in terms of the group-think.

Lori: [Interrupts] The dialogue.

Sydney: [Responds] Right.

Lori: It forces you into a dialogue with other teachers—not just at your grade level. At different grade levels. What you were talking about –the vertical [pointing to Rosalyn]. I really wasn't too concerned about what sixth graders needed to know or maybe just the grade below but preparing them, as well, for the future.

Altha: There's something like that, I forget what it's called, I know one teacher, a friend of mine, she's teaching at another school, and I said, "well what grade are you teaching?" she was teaching like fourth grade, the next year she was moved down to third grade. Most of them did this to show—now I know what I want my fourth graders to know—and so they moved them down to fourth graders need to know. So now you teach what you know the fourth graders need to know! She gave me a term but I don't recall what it's called.

Caroline: Looping.

Moderator: In the essence of time, I want to move to some questions that I have about your mathematics content knowledge. Mathematics, in general, not necessarily how to teach it, although that is a part of it, but mathematics that you've learned from Lesson Study. Can you give me some comments on that?

Lori: I know that I, for one, have begun looking at different ways of looking at ways to divide a certain topic or certain content. But I've looked at, you know, different ways of thinking about the process. That the way that I think about it is definitely not how all of my students are going to think about it. So that there's definitely more than one way to process through solving a problem and still come up with a correct answer.

Rosalyn: Also, for me, it's been fifteen years since college and I've taught kindergarten, first, third, and for me it's been a true refresher course. It's like, I used to know all of this, I used to make all A's, and I kind of forgot some of these things. So for me I was like, "Oh yeah, I

remember that!" And, because you're more middle school [gestures] I haven't really used any of that in a long time and that was something that I needed to get back into.

Lori: Well, I liked the Launch more because now I can get it where it relates to my kids better. I was told/taught with pencil and paper. Now I know I've got to relate it to my kids more with manipulatives so I like the Launch idea and that's something that I can really take with me so they can get a better understanding in how they can use the math in everyday life.

Rosalyn: And I think to move beyond the rule so they actually understand why the rule works. <*Nods in agreement*>

Lori: We're so used to introducing the rule, following the rule, and then telling them.

Rosalyn: It's better to have them do the discovery rather than telling them what the rule is. It's a whole different way of teaching.

Sydney: A lot of the emphasis has been on conceptual understanding and I know all of the rules but I didn't know all of the conceptual understanding… I didn't understand it myself so for me to try to make that transition myself was challenging but necessary for them to understand why we do what we do rather than just applying a rule.

Rosalyn: We learned it a whole different way so we kind of internalize that and it comes out in our teaching. Now we're having to do things differently. The new teachers have had a way different set of methods classes than what ours were. I really have to – I'm not at the top of my game. This continuing education…just because I've been teaching fifteen years doesn't mean I'm doing a great job at all… That I need to adapt what I'm doing.

Moderator: Absolutely

Brenda: Your faculty [Lesson Study Team] needs to have a mixture of brand new teachers, and of experienced teachers.

Rosalyn: And we need to go back to the principals and telling them that we need to have the time to do this together. And that's what's key to me: that the principals tell us, "Ok, you're going to get that time" because we can get so busy doing all of the other things that we have to do as teachers.

[Pause]

Moderator: What did you learn, if anything, from the collegiality of working with one another, of your understanding of the mathematics content that you'll be teaching to your students?

Lori: Some of us learn a little bit faster than others, some of us are a little bit of slow learners, especially when you want to internalize it enough to teach it. You've really got to

master it. And if you're still at that point where you're uncomfortable… Ideas of how other teachers would teach it.

Lori: It's good to pick each other's brains and then suddenly you're like "wait a minute" and it clicks.

Rosalyn: We're finding that when we're teaching our students, we all say the same things, but in different ways. We all have a different take on things but are saying the same thing.

Lori: What other venue can you do this collaboration with than Lesson Study [rhetorical]? If your Lesson Study group is of the same grade level then it really works together because you're able to share new ideas with each other through the comprehensive curriculum. But it works against you, at times, because you have to have the principal allotting time for all of you to be able to get together and collaborate.

Moderator: You mentioned planning times as a potential issue in the Lesson Study Process. Can you foresee any additional issues?

Lori: Related to buy-in of administration: substitute pay. How is my class going to be covered to go observe other teachers' classes? I'm sure there are creative ways with other personnel in the school, but we're just going to have to sit down and try to come up with those ways. And how much disruption is caused by having *x*-number of substitutes in the school teaching these math classes while we're all in another class observing?

Moderator: There's only one more question and this one has probably been answered, but I want to focus in on it. What are you thoughts about how Lesson Study in your school might improve the teaching of difficult lessons?

Lori: Two heads are better than one.

Rosalyn: Ten heads are better than one.

Caroline: The planning of them with the input of the other teachers would be the biggest assistance—especially if it's a difficult one. And the actual implementation with the teachers observing would also help you too because they're not locked down to just sitting there observing. They can walk around, talk to the children…

Lori: It *really* forces you to study. We're so used to that little box (the lesson plan box required by the principals). You've got to break away from that template and we have been as a school trying to come up with an idea for a lesson plan template. Should it be a box? No, not any more. That might be okay for you to refer to during the lesson, but what you turn into your principal has to be more substantial.

Sydney: Also, the whole idea of having the finished lesson plans available for other teachers to use—that way no one ever has to start from scratch when planning to teach these

lessons. They may have to be tweaked to fit your particular classroom setting but they're certainly excellent places to start.

Moderator: Thank you all very much for taking the time to speak with me about this. We'll likely have a follow-up focus group session at a later date to discuss some of the things you brought up today in greater detail.

Appendix E

Transcription of Focus Group B 2008

I read an adaptation of the Welcome, Purpose (modified for this study), and Guidelines from Vaughn, Schumm, and Sinagub's *Focus Group Interviews in Education and Psychology* (1996, pp. 41-42).

Moderator: Welcome and thank you for coming to this focus group. Each of you have been invited to participate because your point of view is important to this study. I know that you are very busy and greatly appreciate your contribution to this study. This interview is *not* a test, nor should it in any way be viewed as a series of questions with right or wrong answers. Remember, I am very interested in what *you* think and feel. I want to know your opinions on these issues, and am certainly not interested in your agreeing with the opinions and feelings of others. There may be at times, however, when you do, and it is appropriate for you to let us know that as well.

The purpose of this focus group session is to determine your ideas and opinions about the affects, if any, of Lesson Study on your teaching and your students' achievement.

There are a few guidelines I would like you to follow during the focus group session. First, you do not need to speak in any particular order. When you have something to say, please do so. Second, please do not speak while someone else is talking. Sometimes, the exchanges get emotional, and it is tempting to 'jump in' when someone is talking, but I ask you to refrain from doing so. Third, remember that there are many people in the group and that it is important that we obtain the point of view of each of you. Fourth, you do not need to agree with what everyone or anyone in the group says, but you do need to state your point of view without making any negative comments or 'put downs.' Finally, because we have limited time together, I may need to stop you and to redirect our discussion. Do you have any questions? Okay, let's begin.

Moderator: I know each of you has done a lot of thinking about Lesson Study over the past several months and working with your colleagues on developing a Research Lesson for your students. I'd like for you to describe what Lesson Study means to you as if you were describing it to someone who didn't know what it was.

Lori: It's a process of creating your lesson where teachers are collaborating and trying to develop a lesson. It's observing a lesson, trying to polish it to make it better for the students using the technology, manipulatives, and such in that lesson that promotes better understanding with higher-level thinking skills and high-engagement.

Brenda: A major part of that is the research that takes place that goes into developing that lesson: The data that you are looking at from your school: what need, what area, what topic area needing more emphasis for a better way to teach it, a better way to get to the children—the content to the children—a higher level of understanding and that I think that's good that the different grade levels collaborate together as well. How it's going to affect the grade above and the grade below you and I think that it's meaningful for the entire school. <*Trying to choose her words carefully.*>

Moderator: Tell me about the [student scores she just talked about].

Brenda: We look at [state standardized test scores] scores, we interview teachers, we came to the conclusion that *x* was a skill across the board that needed more attention to bring up the scores, to affect student learning. So we researched that, we got all of our scores from the principal, went through the strands, specifically what topic in measurement needed more improved instruction to help improve the grade.

Moderator: Looking at that student data, there are several indicators of what areas that need improving. Tell me a little bit about working with teachers from other grades—higher and lower.

Brandi: Part of this process, you can't just take one grade in isolation. We had to go through kindergarten, starting at the base level with time, which is what we had to know what the foundation was and go with that all the way through and then chose a grade level that would have the greatest impact and go from there.

Moderator: So you looked at … above and below …

Brandi: <*Interrupts*> …And what outshoots from each one of them. And what prior knowledge has to be from each grade level as you go up to master that skill.

Will: Chance of opportunity that teachers have or maybe have but have the chance to sit down with colleagues and watch because we are all in our own environments and we don't even know that other people are doing something in their own room. We all assume that we're doing the same thing or not doing the same thing—teaching the same thing but everyone is different. That portion is something that continues … not having the opportunity to watch others corroborate the couple of things that is different; a different way of teaching that helps you. More than one way to skin a cat and I like learning new ways that comes with the Lesson Study Process – the observation. How I could share and hear suggestions to each other on how the area observation … I like that. It's moving beyond the typical four walls of your own classroom by working with your other teachers.

Brenda: It definitely opens the line of communication for us. I run down to the 4th grade teachers' rooms and ask, "What are you doing? And I just did this!" And that definitely helps us be in the same line of thinking.

Moderator: How have you experienced the process of Lesson Study with peers and your students? You mentioned the collaboration going on, the working with other teachers beyond the grant, for example … with your students… tell me how that's starting to work.

Brenda: For me, I have looked at my students in a different way. Actually looking at how they work on their test. It definitely changed me into hopefully a better teacher and I think there's a lot more emphasis now of letting the children discover rather than me always saying this is what we're doing, so I find myself holding back saying, "Now you do it," and focusing on the children more and how they learn instead of just showing them how things work.

Moderator: So not so much this rote, this stand up lecturing the students.

Brenda: Yes.

Moderator: Getting them to construct their own knowledge.

Brenda: And it builds them up. Helps them with what they're doing now. I find that examining this data and looking at where they are, that works to help figure out what sort of environment to create so that they can construct their own knowledge?

Brenda: Yes.

Moderator: Can you talk a little bit more about that?

Brenda: Me?

Moderator: How do you know where to start? You said you want the kids to construct their own knowledge. How do you know how to create the environment so that they'll be able to construct new knowledge?

Brenda: It's about allowing them the freedom to be able to interact with each other about ideas and that they don't have to sit in a desk and just pay attention to what you're saying or what's just coming out of your mouth through direct instruction. It's giving them a lot of open-ended questioning so that you can say "now talk to your group about this" and see what they can come up with and believe it or not they actually do discuss what you've asked them to discuss and use the manipulatives themselves with out me really having to say much where in the past I would have normally said, "now today we're going to learn blah-blah-blah and construct blah-blah-blah with the manipulatives" and they'll surprise you with what they're able to construct by working with each other.

Will: For me it was being here on a Saturday with the other teachers and just observing how we interact with each other, how just it's refreshing to see, it's kind of like I see the same thing in my classroom with the adults, with us, how we discover things, how we share things, how we learn things as adults, I see the same stuff in the classroom. Just seeing us work on Saturdays ... just the whole process of us getting together. Not specifically just how we're going through the training and working together, it helps me with my students and knowing how to deal with them a little bit different.

Altha: I think it's very important to relay the topic of your classroom with reality and a problem that is … that was very important to me.

Brenda: Something that is meaningful to them.

Raymond: When I taught the first part of the Lesson Study this week, about 1/3-way through it took off and about 1/3-way through I realized that I missed a key part of the script which was modeling exactly how it could be done. The day before we had done some work in the same area on a one-step equation, but for the two-step, that second step of division – I realized 1/3 of the way through that I hadn't modeled that you want to create these rectangles that teach you to divide with manipulatives to model that. It's really important if you take the time that we did to develop the script, to follow the script… With twenty-four kids, they were going and presenting, and really into it because they were excited about what we had started yesterday. I realized that I had left a key part of the script out, and someone mentioned the word "modeling" a second ago. It's critical. Even though you want to let them go, it's critical to model it one time for them. You've taken all this time to plan the lesson, anticipate the students' questions and anticipated their responses, and what you're saying is even though it's great to let the kids go with it. One key thing for me was model it one good time so they'll have it. I think they did pretty well but that was critical.

Brenda: And having that in the Lesson Study, I can relate to completely because I tried to follow the script a little too much and afterward felt that I missed this opportunity, I missed that opportunity, and instead of letting the students try my instruction, because as we know in the classroom you can have the best laid plan, and the students who either are getting a concept or not getting a concept you may have to go back and say ok what is it that I need to do right now to make sure that they're understanding what was going on. Lesson Study is giving us the opportunity to try that first and next time it's going to be awesome. They can't help but be fabulous. You know what to do, what your mistakes have been, and next time it's there to really help you out.

Will: I think this whole process is something that should be put in place in your school and even in your district where you can have in-house professional development. We're so transient in education these days that there should be legacy things that we begin to leave behind. I think especially the Lesson Study Process is one that can help put together packages, videos, written documentation that can stay in a district/school so the next person coming in doesn't have to reinvent the wheel with professional development. All the math teachers are going to sit down and watch last year's team that put together the lesson for this, this, this subject or the other and help them go through the process because our schedule is setup where we're supposed to have those times where we collaborate but the time is there but I haven't seen a lot of organization of the staff so that they know how to utilize that time efficiently. They want us to utilize it but then me and Raymond weren't coming here on Saturdays we would utilize it in that fashion.

Lori: The one thing for me that is very significant is how you look at assessment and how attached we were to the formal assessment we had and how much more you can absorb and learn of how much your kids know of the process is through other forms of assessment. Not only the formal but it all goes into assessment. The importance of having your rubric so they are aware of what you expect in the group projects, the observations… now my kids are totally prepared because they know people are observing them for the purpose of assessment. To also teach the

parents that there are other forms of assessment going on… "Don't be so attached to the letter on one test… and not to be so attached to a letter grade."

Moderator: A couple of you used a word—and I just want to touch on this for a second—you used the word "script." In current pedagogies that's a word that has negative connotation and for clarification, I want to talk about just briefly that some of our RSD schools, for example, use scripted lessons where the teachers are basically given word-for-word, to the minute, this is what you should be saying. How does what you're doing compare to that? Because you used the word "script" and "the importance of sticking to the script," tell me how that is similar or different than other forms of scripting. Or just tell me what you mean by a script?

Brenda: I guess I mean that I'm just making sure that I'm hitting the important concepts that I want them to reach. Were they able to formulate the chart correctly?

Moderator: So you weren't necessarily meaning word-for-word?

Brenda: No. <*chuckles*>

Brandi: To make sure that you're achieving what you were planning to achieve with the students.

Raymond: And when I use the word "script" I just mean the formal lesson plan. Not a word-for-word thing. I said that because I had to interject myself and actually show them you know the division part of the two-step equation. You really want to form a nice rectangle, with your three Xs and then three rows, etc., and toward the end. I had omitted something critically and I learned that I needed to make sure that I did everything with the kids that I meant to do.

Moderator: You've talked to me about some positive things that you've found in the Lesson Study Process. Can you tell me about some negative things that you've found, anything that maybe happened that you didn't expect?

Lori: I'd say a negative thing is what we just talked about: being caught *looking* at it in a narrow way—not as a guideline… sometime you might miss that opportunity that might come that you can't predict, and every group of kids you teach, there's going to be a different dynamic, and the script does not, the guideline does not predict that. So having that flexibility sometimes—especially if you're being observed—you try to say everything and you can't.

Brenda: Having to practice the first time, makes you realize – I was completely self-conscious that first time—making sure that I did hit what I was supposed to and another teacher said, "You don't teach like that!"

Lori: We know her!

Brenda: But next time I know that I can pull myself away from that because I'm familiar with it, I know how it's going to flow, and things like that. So in that respect, doing it once and

then being able to do it again, I think we packed way too much into one lesson. Things which maybe I had in my regular plan for that and now we know to go back and make two lessons instead of one.

Lori: They should be balanced between the reaction and <Inaudible>. You have to be able to flow with the kids and not so much what you have set up to say.

Will: In trying to answer your question about negative, I find it hard pressed to find anything negative whatsoever in doing this because planning is really the foundation and basis of delivery. If we don't plan well, our delivery is going to be hap-hazard, going anywhere and everywhere. I just can't find a negative but what I do see is a problem with it is time in general. The time needed to get it done. The time needed to plan.

Brenda: The time within a school day or after school for this is key for me… and how to pull in other teachers to meet with us to get input from them as well. When you're talking about different grade levels, we all have different activities scheduled all the time. So that made it a little bit more complicated for us at the elementary school level.

Moderator: And that's why Lesson Study is designed for only one or two per semester. But just in you saying that, what do you think would help remedy that?

Will: Money.

<Silence around>

Moderator: Money? *<All laugh>*

Lori: No, I would say if you spread the effort into more schools … what I would say my dream vision: to have all these lesson plans created by different teachers at different schools, have an electronically repository for any teacher anywhere because the focus is the lesson… anybody can just use them which will make it easier for teachers anywhere to having to reinvent the wheel with every lesson. We still have to revamp according to your particular classroom…

Brenda: <*Interrupts*> The basic lesson is there and we take it outside of just your school building so that anybody who needs something is only one click away.

Lori: You know, I want a good lesson on this, I know you have one, I'm going to find one… and it's already there for you.

Brenda: That's the structure of a research lesson. You know it's already been researched, taught, perfected, and you know

Moderator: So that's different than other repositories that are out there already that say, "well we've already got a lesson on that."

Lori: But it's not research based.

<*Several seconds of silence*.>

Brenda: So it may be that you want to go back and make it more meaningful for our students in our building.

Moderator: In your own schools, you mentioned it's difficult to get teachers together especially across different grade levels in your own schools, can you think about any way that might be improved?

Brenda: Everybody in the school knows the grant and what we do. We constantly are talking about the launch, making it real, this that, not just in math content, but talking about it in our school, in the hall—we are making this a part of the school culture.

Rosalyn: Any grade level, any teacher, could come as we went over what our concerns are… what we're doing. We actually have an agenda, take a minute during our after school team meetings.

Moderator: So your principal was on-board for this?

Lori: Definitely. That's one of the most critical parts.

Rosalyn: Every teacher doing observations this year as part of a school-wide movement – outside the realm of the grant so we all had to get observed and observe … looking for different things, etc.

Moderator: One of the steps of the Lesson Study Process you described is the collaboration aspect that goes on between two of your colleagues. Please describe what goes on during your Research Lesson for the collaboration piece.

Rosalyn: We look at what we've done, what the kids' needs are–the kids can't do this, they're having trouble with this. We're trying to align what we're doing in second and third and fourth and fifth into a curriculum map for the school in math in particular. So that then *x, y,* and *z* in third, fourth, and fifth are pretty much on unit of measure at the same time and we're able to discuss situations that we're facing… things to keep in mind so that…Ok all you need to go over is to here in third, and I'll pick it up here (in fourth grade) so that then she can pick it up there in the fifth grade and maybe go broader, or deeper.

Moderator: Think about what we've been doing in the Lesson Study Process. Is there anything that we've done that has made you feel more comfortable or more uncomfortable working with your colleagues? You've mentioned that now you're able to think beyond your four walls of your classroom. Do you find yourself talking to other math teachers at [one school name] or at [another school name]?

Altha: (Basically a repeat of Rosalyn's comments above.) Difficulty getting other teachers to work with her whenever other teachers are a part of other teacher professional development programs … they've all got their own things to do.

Moderator: An extension of that question is: Do you think it would help if you had other teachers from your school involved in the Lesson Study Process?

Altha: Very much so.

Moderator: Can you just tell me a little bit about what you're thinking?

Altha: We would be able to collaborate with them a lot more. Ok, we do collaborate, and I heard about another school where the teacher who taught third grade went down to second grade… To know what they have problems with at different grade levels.

Raymond: During our Research Lesson collaboration meetings, we analyze step-by-step the template that is provided for us for our Lesson Study guide. We looked at different videos that were available online, we looked at different manipulative packages—rods, base-10 blocks, we looked at online drag-and-drop manipulatives… We planned so much we didn't get to touch on ½ of what we planned on. There was just too much planned for one session. We really needed to pare it down and do one thing good.

Will: Your question about other teachers in the building. I want to address the other subject areas. Most of us teach math, but science, ELA, social studies… I think getting them involved is really, really good because I think those teachers need to collaborate more, those teachers need to see what other practices that will work well in their room. I have an ELA teacher right beside me talking about how the students know what to expect when they get into my room, they're wondering how kids who are bouncing off of the room in their room, don't do that in my room. I don't know what works for ELA classes… I know in math what I need to do to get the kids self-directed in my class. So another teacher in math can come in because we can collaborate and they can take something from my cart over here and they can plan over here and take this to their classroom. I think those English teachers need to collaborate together because in one class it might work, in another class it might not work. I think that's what we need to do—get teachers involved in other subject areas. I do work with my lower grade teachers too. I'll watch her or she'll get to watch me do things and we learn from each other… that collaboration and observing.

Brenda: Scheduling problems. Also, money, and the principal can only do so much to allow us the time that we all should have to get together.

Lori: We have to look at the amount of time we have to teach the kids. And what really matters – there is a gap there. I think we're up there shoving too much stuff and we leave the substance very weak and I think the whole …. Has to be revisited because 1/3 of my … we don't pay enough attention to what's core.

Brenda: I think there's a lot of pressure on all of us to make sure that *every* concept is covered. We need to look at what's most important to teach about this particular topic and what they need to do… and then stick to that as much as we can. That collaboration: You mean we don't have to teach to the hour to the minute in third grade, then I don't have to teach to the second if that's what's covered in fourth. We shouldn't have to overlap so much. We're not tied to that math textbook and we shouldn't feel like we have to cover everything in there just because it's in there. If I'm teaching multiplication or decimals and that's not covered until chapter eleven, why do I have to drop it here and then pick it back up in the spring? Why can't I connect these concepts to everything that I'm doing—with multiplication, with division, or whatever.

Moderator: Do teachers who are not involved in Lesson Study not do this?

Lori: We have teachers who are not involved with Lesson Study helping us out.

Moderator: What caused you to go through this process? What I'm trying to get at is this: Did you do this type of textbook alignment with the GLEs before you were involved in the Lesson Study Process?

Brenda: I think it's related to what we wanted to cover because of our focus in this program and we had to wrap our head around that in math … When you're trying to revamp a math curriculum, it's almost like "where do you start?" and so you have to go through the different areas of the book to find out what's related to each other. It helps give you a push and a focus to work on the curriculum alignment. Where does first grade start and stop and move to second and all the way throughout the school. Everyone brought their textbooks and aligned with GLEs what was covered at each grade level to cut out what was being taught the same way over and over and focus on those things which were lacking the proper amount of depth as indicated by the GLEs.

Raymond: Correlate what we're teaching in the books with the [state standard achievement test] tests and pluck out those things that aren't necessarily needed.

Moderator: So Lesson Study is one form of teacher professional development that teaches you collaboration, teaching each other. Would you say that it gives you a thrust/motivation to really take charge of what the curriculum guidelines are, what the GLEs are?

Brenda: I'd say so. I think that it's ongoing teacher professional development. We've all, I think, are aware of the GLEs. This is about connecting things… to improve the way that we teach.

Lori: I don't like the GLEs. I refer to the standards quite often but then see how it follows the NCTM standards. I don't think the GLEs are well-structured. But to just look at them, I think they set the standards lower than they should be. There are plenty of things there that shouldn't be and I have several questions on them, so I keep asking questions. I have to have that point of reference—after all we're all worried about those scores. If I don't have the NCTM standards, I get lost. I prefer to use that as my guide.

Moderator: You've been collaborating with other teachers on the development of your research lessons for about five months now. During that time, you may have discovered new ways of understanding the math content. What new understanding has developed as you've been working in the Lesson Study Process?

Altha: I've found that I like teaching math; it's gratifying. But when we took that first pretest, I guess I didn't read through all of the rubrics and I got points taken off because I just put down the answer. But when I gave my students the pretest, I graded them according to the rubrics. And it's very difficult—it took me a lot longer to grade it that way—because many of these were just right/wrong—but now 4, 3, 2, 1, 0 points, and I found that now I'm grading other work the same kind of way, it's not just right/wrong. It's looking at how they're doing. Now I can show them what they didn't understand… things like that. It helped me create my lesson in a different way.

Moderator: I just want to ask one more question for clarification: We're looking at your content knowledge, how the Lesson Study Process has impacted your content knowledge. If you can, bracket or separate what you learned as a part of the grant, as opposed to what you've learned from working with each other, in this collaborative Lesson Study Process. Clearly you learned content here, but was that really from the Lesson Study or was that from our workshops here?

Brenda: Pattern blocks to teach fractions.

Moderator: And that's kind of it, that's kind of pedagogy, but did you learn any new math?

Brenda: Like how to add or subtract fractions…

Moderator: Exactly… sure…

Brenda: I always say that my math content is for fourth grade and below, so yes I had to go back and think about what I learned back in college, but I think that you have to make sure that the content is above what I teach to prepare them for the next grade level.

Will: For me, I've learned how to do more math but I was discovering more ways of doing the same math… the things that I had never really done with the manipulatives—not that I was afraid of them—but then linking my deep understanding of math as it is to the hands-on manipulatives that the students would use. The result was that I had this growth to new ways of thinking about certain math concepts. It taught me new ways of understanding how to do certain things, not just one way of doing them.

Moderator: So what you're saying is that the conceptual understand of what you're teaching is growing rather than applying one hard-fast algorithm for solving a particular type of problem. Instead you're learning more than one way of looking at particular types of problem.

Sydney: We'd never done division of fractions this way. It makes sense! But the reason that we do multiplying first is because not all problems work out so nicely. But some problems do – where you can divide them directly… and I had never thought about that before until I had to anticipate how students were going to learn things … and became acutely aware of paying attention to the students' learning process.

Lori: Looking at the students' learning process has made me more aware of how the students think. I'm no longer mainly interested in whether or not the students' answers are right or wrong, but how they processed their answer. By having them teach me their ways of doing things, I learn from them but it also helps me identify when students aren't processing the problems correctly and I can go back and correct their misconceptions rather than just assuming that they know what they're doing since they got the questions correct. They think that they can do all of the problems, but they can't. They memorize something that looks like a rule that I should do to make it easier (shortcut) and then they get it wrong… and then I have to try to undo the damage. I think with the manipulatives, I have to research how they're going to do it because they initially rejected the way to do it… so I have to take more time convincing them that it's ok to get confused and that that's part of the learning process.

Brenda: They have to be able to explain to me. When they can, that's when I know that they've got a conceptual understanding of what we're doing. When they can't, that's when I have to tell them not to get so frustrated, but to slow down, go back, and they need a little more time… without the immediate gratification. They don't like the negative impact of frustration that is a necessary part of problem solving.

Raymond: I try to impress upon my kids that more good comes from the unknown than the known sometimes and that being confused means that they're about to learn something new.

Moderator: One last question… How do you feel Lesson Study has affected your students' achievement? Has it?

Lori: I would hope so but since we're still in the middle of the process it's too early to determine.

Moderator: Fair enough, but do you think that by spending more time through the Lesson Study Process development of the research lessons… do you think that this has the potential for improving your students' achievement? Or not?

Raymond: I think the potential.. yes. It's a wait-and-see thing right now. It takes time—you have to do it over time. Because this is one lesson—one or two a year—you need to have more lessons already put together to address those areas that are really tested on kids. You need some time, years, to test.

Lori: To be able to produce results, it'll take time. You're changing the way we teach and the way that they learn. We're all being more critical and going through things with a fine-toothed comb.

Will: Based on the Lesson Study Process of taking a lesson, collaborating on its development, taking it, teaching it to the students, revising it, teaching it to a different set of students, and then continuing to revise the lesson until you're satisfied with it… I would be hard-pressed to find another method of increasing student achievement beyond the Lesson Study Process.

Moderator: As we come to a close, I need to remind each of you that the video tape will be transcribed, that you will be assigned false names for the purpose of transcript and data analysis so that you will remain anonymous, and then the tape will be destroyed. I only ask that you refrain from discussing the comments of the other group members and that you respect the right of each member to remain anonymous. Are there any questions I can answer?
Thank you for your contribution to this study. This was a very successful session and your honest and forthright responses will be an enormous asset to my work. Again, I very much appreciate your involvement. (Vaughn, Schumm, and Sinagub, 1996, 47-48)

Appendix F

Miscellaneous Responses

Question Code Legend

Year	Instrument	Question No.	Example
2007	Survey (Surv)	*varies*	07Surv12 =
2008	Questionnaire (Quest)		Survey, Question 12, 2007
	Focus Group A (FGA)		
	Focus Group B (FGB)		

Question Code	Response	Category
07FGA	Different manner of communication since many of the principals dropped the ball. LINCS leaders should've been here. They said that they didn't have to come.	Buy-in from Administration
07Quest5	An issue would be teacher administration buy in because many may view the process as more work.	Buy-in from Administration
07Surv12	Principals are not as enthusiastic as the lesson study group. We need more support from all principals!	Buy-in from Administration
07Surv12	I feel that sometimes I don't have the time to plan that thoroughly.	Buy-in from Administration
07Surv12	A disadvantage of the process is not having input or buy in from administration.	Buy-in from Administration
07Surv12	Finding time that works for everyone and having the district force what you are to do in that time, for instance [school district name] meets 3:15-4:15 on Thurs but the format we use is forced and it's not lesson study; however, they know that they gave us what we are to do.	Buy-in from Administration
07Surv12	They should be schoolwide. Teachers and principals should all working together to help the teacher do their best.	Buy-in from Administration
07Surv15	There is a need for more support from administration and community leaders of the lesson study process. Observers of the lesson study open house should focus more on the lesson and not the teacher.	Buy-in from Administration
07Surv15	I think principals should provide time and assistance to the teachers in lesson study. I think this class should be mandatory.	Buy-in from Administration
08FGA	Tell school administrators that we have to have the time. Have to have the principals to agree to teach us that time.	Buy-in from Administration
08FGA	Time. Principal buy-in. Support of your principal. Finding the time to observe, work w/ the teachers.	Buy-in from Administration

08FGA	Pay for subs. For them to be released to go watch a teacher to teach the lesson. Creative ways. Has to become a priority.	Buy-in from Administration
08FGA	What about making it schoolwide? Consistency of the staff. There are only one or two locked-in math teachers. Basis before school begins to do the Lesson Study process effectively. The stability of the school / change in staff, hiring staff, etc.	Buy-in from Administration
07FGA5	The participants have to be able to work with other people.	Collaboration
07Surv12	Being by myself was the only disadvantage but I did ask my LINCS group to help me.	Collaboration
07Surv12	I'm the only one from my school	Collaboration
07Quest5	Getting other teachers to commit.	Commitment
07Quest5	Yes, some teachers do not want to commit to such a "study" and don't have time.	Commitment
07FGA5	Some will put up a road-block. They take peer reviews too personally.	Observation
07FGA5	Have to get through the sensitivity issues.	Observation
07Quest5	I have already taught in a "Peer Teaching" environment and did not have any problem with it. My only problem is when I am observed. Since this is only my second year teaching I am my worst critic and get nervous when observed. Thankfully the feedback I get has been very positive. I think I am always try to improve and hard on myself.	Observation
07Surv15	Teachers observations and/or comments should be on the lesson and not the teachers. I think it would be more effective also if principals could attend a "Get Acquainted" session to understand what the Lesson Study is all about and how intense it is.	Observation
08FGA	How disruptive will it be to have so many subs teaching the different classes?	Observation
07Quest5	I currently have a good working relationship with 2 teachers I hope to work with. The problem will be potentially related to creating a valid instrument/lesson plan that will work for the particular students.	Planning
07Quest5	No. I think we comprise a great team. All of us have worked together for years and have shared lessons in the past. I think the only problem we may have is convincing other teachers to go through the same steps when planning a lesson.	Time
07Quest5	Resistance from other teachers.	Time
07Quest5	Teachers may not be willing to participate in the study because they feel it's more work for them.	Time
07Quest5	I have a concern about trying to get teachers to be wiling to participate in the Lesson Study. One complaint that the teachers have is that their plates are full and that there is not enough hours in a day to accomplish the requirements of the state/parish.	Time
07Quest5	I think that the group of teachers we have present at this workshop will be successful and supported at our school as we go through the process. The more difficult aspect will be to encourage other teachers to join the process.	Time
07Quest5	Time is always an obstacle. Finding the time for us to observe each other will be a chore. We are from three different schools. I did try to recruit other teachers.	Time
07Quest5	The one problem that I foresee with peer teaching and the Lesson Study Process is time management.	Time

07Quest5	We are currently participating in the LINCS whole faculty study groups. These groups are cross-curriculum and meet for 1-1/2 hrs. every other week. Our faculty will have difficulties/problems with implementing another program because of scheduling conflicts. After school is an option; however, so many of us sponsor extra-curricular activities already.	Time
07Quest5	Time may present a problem because of the scheduling nightmare that we all face in school. Teacher longevity may present a problem because we will need the teachers to start the process and see it through to completion.	Time
07Quest5	No except the dates may be an issue as well as time.	Time
07Quest5	The only problem would involve time.	Time
07Quest5	Yes, some teachers don't want to be bothered, they call it extra work.	Time
07Quest5	Time restraints → different planning periods. Too many other obligations from my school → 4-H, LTAP, Safe and Drug Free Facilitator, etc.	Time
07Surv12	Some teachers may find it too time consuming.	Time
07Surv12	Time is a factor for myself. Finding the time to meet as well as getting an opportunity to observe without the issues of class coverage. I also believe that meetings should be less scattered (whole-groups on Sat.).	Time
07Surv12	Time is the biggest disadvantage to the lesson study process. Teachers have multiple duties and unfortunately sometimes those duties prohibit the participation in the lesson study process.	Time
07Surv12	The disadvantage for my team members and me was finding time that fits the whole group.	Time
07Surv15	I think if the state wants to make an effective change in the way in which teachers deliver lessons to student then there is a need for more preparation time for teachers before the school year begins. In addition to more prep time at the beginning of the year teachers need at least one day a month to collaborate with colleagues, review lessons, and assess students' progress. This can be accomplished by grade levels or across grade levels. Teachers and students have teaching and learning jammed into a 6 hour day, and that is too tight of a time constraint if we are to improve on basic skills in reading and mathematics. Adding a mere 45 minutes to the school day would allow students and teachers to work at a more reasonable pace, and include more in-depth lessons.	Time
07Surv15	I find that whenever [observers from the grant] came to observe a team member, them coming in to see me too became a bit too much, because of the formality that it takes in planning this kind of lesson (meaning not every subject is easy to find manipulatives for).	Time
07FGA5	Some will be unconvinced that a new way of teaching may be better.	
07FGA5	In any school, you're going to have those who are resistant. "This is how I've been doing it all these years and it works my way." Don't force anyone to join in. Once they see it working well for others, they'll want to follow suit.	
07Quest5	Not yet. I don't think I will be ready to face any issues until I hit the lesson study head on.	
07Quest5	I am new at my school and don't know any one other than Kiaun Williams (who is great to work with!). I'd like to include others - but she (whoever) must be a 'team-player'!	

07Quest5	The restrictions for the different members. Some teachers live far away and ride the school transportation and have to leave at a certain time.	
07Quest5	I do not see any major problems. We are a LINCS school and all teachers are participating in Whole Faculty Study Group. Most of us are open to new ideas and work cooperatively. I am sure there may be some not as open to new ideas or interested in extra work.	
07Quest5	With being a LINCS school, I think most of the teachers will be willing to listen and take something back, however, some teachers will not be willing to change.	
07Quest5	Just encouraging people to participate.	
07Quest5	No, we tried it last year -- my staff should be better at it this year.	
07Quest5	I may need to form a group with other teachers at my school to accommodate higher grade levels. It will help with expanding on concepts as the students progress.	
07Quest5	Because I am the only one participating in LaSIP I feel I am always the "teacher" for process and not the peer.	

Appendix G: Statement of Informed Consent for Surveys

Perspectives of Lesson Study Impact on Teaching and Student Achievement

Principal Investigator: Yvelyne Germain-McCarthy, Ph.D., 504-280-6533, ygermain@uno.edu
Co-Investigator: Thomas Wright, 504-280-6606, tdwright@uno.edu

- **Introduction of the surveyor**: I am a doctoral student under the direction of Dr. Yvelyne Germain-McCarthy of the Department of Curriculum and Instruction at the University of New Orleans. I am conducting surveys in order to study teacher perspectives on the effects of Lesson Study on teaching and student achievement. I am requesting your participation in this project.
- **Purpose of the research**: You are invited to take part in a study related to teaching and learning. Before you decide to be in this study, you need to know the risks and benefits. This consent form tells you about the study. If you have any questions, please ask me or Dr. Germain-McCarthy. Signing this form means that you agree to be part of this study. The purpose of this evaluation study is to understand some of the effects (if any) that Lesson Study has on your pedagogical skills and mathematics content knowledge, and on student achievement. The surveys will be distributed throughout the semesters either in person (hard-copy) or via email using www.surveymonkey.com (online survey).
- **Foreseeable risks**: During the surveys, you may be asked personal information as it relates to your background, experiences, preferences, and teaching experience. If you are uncomfortable with a question, please skip that question.
- **Benefits of the research:** There is no compensation for this survey, and your participation is entirely voluntary.
- **Alternative procedures:** There are no alternate procedures for this study. Refusal to participate in this study will involve no penalty or loss to the individual either in this study or as a participant in the LaSIP grant. In addition, you may discontinue participation at any time without any penalty whatsoever.
- **Confidentiality of records:** Participants' names will not be used in the reporting of results of this evaluation. Only teacher IDs (which will be assigned by the PI at the beginning of the study) will be used throughout the surveying process. The transcript data will be stored electronically using unique IDs. The results of this evaluation will be submitted to the University of New Orleans as data supporting my dissertation research, to the funding agencies of this grant (the Louisiana Board of Regents and the Louisiana Systemic Initiatives Program), and may be presented in conferences or published in scholarly works related to Lesson Study. You name will not be used in any of these documents as a participant in the evaluation process.
- **Contact information:** If you have any questions regarding the research or your rights as research participants, or in the event or a research related injury, please the Principal Investigator, Dr. Yvelyne Germain-McCarthy at 504-280-6533 or ygermain@uno.edu . If you wish to talk to someone about your rights as a human subject, please contact Dr. Ann O'Hanlon at aohanlon@uno.edu or 504-280-6501.

Your signature states that you are volunteering to participate in this study.

_____	_____	_____
Participant's Name	Participant's Signature	Date
_____	_____	_____
Surveyor's Name	Surveyor's Signature	Date

Appendix H: Statement of Informed Consent for Questionnaires

Perspectives of Lesson Study Impact on Teaching and Student Achievement

Principal Investigator: Yvelyne Germain-McCarthy, Ph.D., 504-280-6533, ygermain@uno.edu
Co-Investigator: Thomas Wright, 504-280-6606, tdwright@uno.edu

- **Introduction of the participant**: I am a doctoral student under the direction of Dr. Yvelyne Germain-McCarthy of the Department of Curriculum and Instruction at the University of New Orleans. I am conducting questionnaires in order to study teacher perspectives on the effects of Lesson Study on teaching and student achievement. I am requesting your participation in this project.
- **Purpose of the research**: You are invited to take part in a study related to teaching and learning. Before you decide to be in this study, you need to know the risks and benefits. This consent form tells you about the study. If you have any questions, please ask me or Dr. Germain-McCarthy. Signing this form means that you agree to be part of this study. The purpose of this evaluation study is to understand some of the effects (if any) that Lesson Study has on your pedagogical skills and mathematics content knowledge, and on student achievement.
- **Benefits of the research:** There is no compensation for this survey, and your participation is entirely voluntary.
- **Alternative procedures:** There are no alternate procedures for this study. Refusal to participate in this study will involve no penalty or loss to the individual either in this study or as a participant in the LaSIP grant. In addition, you may discontinue participation at any time without any penalty whatsoever.
- **Confidentiality of records:** Participants' names will not be used in the reporting of results of this evaluation. Only teacher IDs (which will be assigned by the PI at the beginning of the study) will be used throughout the questioning process. The transcript data will be stored electronically using unique IDs. The results of this evaluation will be submitted to the University of New Orleans as data supporting my dissertation research, to the funding agencies of this grant (the Louisiana Board of Regents and the Louisiana Systemic Initiatives Program), and may be presented in conferences or published in scholarly works related to Lesson Study. You name will not be used in any of these documents as a participant in the evaluation process.
- **Contact information:** If you have any questions regarding the research or your rights as research participants, or in the event or a research related injury, please the Principal Investigator, Dr. Yvelyne Germain-McCarthy at 504-280-6533 or ygermain@uno.edu . If you wish to talk to someone about your rights as a human subject, please contact Dr. Ann O'Hanlon at aohanlon@uno.edu or 504-280-6501.

Your signature states that you are volunteering to participate in this study.

_____	_____	_____
Participant's Name	Participant's Signature	Date
_____	_____	_____
Surveyor's Name	Surveyor's Signature	Date

Appendix I: Statement of Informed Consent for Focus Group Sessions

Perspectives of Lesson Study Impact on Teaching and Student Achievement

Principal Investigator: Yvelyne Germain-McCarthy, Ph.D., 504-280-6533, ygermain@uno.edu
Co-Investigator: Thomas Wright, 504-280-6606, tdwright@uno.edu

- **Introduction of the participant**: I am a doctoral student under the direction of Dr. Yvelyne Germain-McCarthy of the Department of Curriculum and Instruction at the University of New Orleans. I am conducting focus group sessions in order to study teacher perspectives on the effects of Lesson Study on teaching and student achievement. I am requesting your participation in this project.
- **Purpose of the research**: You are invited to take part in a study related to teaching and learning. Before you decide to be in this study, you need to know the risks and benefits. This consent form tells you about the study. If you have any questions, please ask me or Dr. Germain-McCarthy. Signing this form means that you agree to be part of this study. The purpose of this evaluation study is to understand some of the effects (if any) that Lesson Study has on your pedagogical skills and mathematics content knowledge, and on student achievement.
- **Benefits of the research:** There is no compensation for participating in the focus group sessions, and your participation is entirely voluntary.
- **Alternative procedures:** There are no alternate procedures for this study. Refusal to participate in this study will involve no penalty or loss to the individual either in this study or as a participant in the LaSIP grant. In addition, you may discontinue participation at any time without any penalty whatsoever.
- **Confidentiality of records:** Participants' names will not be used in the reporting of results of this evaluation. Only teacher IDs (which will be assigned by the PI at the beginning of the study) will be used throughout the questioning process. The transcript data will be stored electronically using unique IDs. The results of this evaluation will be submitted to the University of New Orleans as data supporting my dissertation research, to the funding agencies of this grant (the Louisiana Board of Regents and the Louisiana Systemic Initiatives Program), and may be presented in conferences or published in scholarly works related to Lesson Study. You name will not be used in any of these documents as a participant in the evaluation process.
- **Contact information:** If you have any questions regarding the research or your rights as research participants, or in the event or a research related injury, please the Principal Investigator, Dr. Yvelyne Germain-McCarthy at 504-280-6533 or ygermain@uno.edu . If you wish to talk to someone about your rights as a human subject, please contact Dr. Ann O'Hanlon at aohanlon@uno.edu or 504-280-6501.

Your signature states that you are volunteering to participate in this study.

_____	_____	_____
Participant's Name	Participant's Signature	Date
_____	_____	_____
Researcher's Name	Researcher's Signature	Date

VITA

Thomas Wright graduated *magna cum laude* with a B.S. in computer information systems and a B.A. in music from Louisiana Tech University in 2001. In 2007 he received an M.B.A. from the University of New Orleans and in 2009, a Ph.D. in curriculum and instruction with a concentration in mathematics education from the University of New Orleans.

Dr. Wright served as a software developer before returning to academia to answer the call of educating adolescents and adults in mathematics and mathematics education. For the past two years, he has served as research assistant on a grant funded by the Louisiana Systemic Initiatives Program. He is also an organist in the archdiocese of New Orleans. Since being forced out of his home in Mid-City after the flooding of Hurricane Katrina, he has resided in the Bywater area of New Orleans.

UNIVERSITY of NEW ORLEANS

Name: Thomas David Wright, Jr.

Title of Manuscript: Investigating Teachers' Perspectives on the Impact of the Lesson Study Process on Their Mathematical Content Knowledge, Pedagogical Knowledge, and the Potential for Student Achievement

I release the aforementioned student's manuscript for review by the Dean of the College and verify the following:

I. I have read and approved this manuscript.
II. The research involved in this study conforms to the regulations of the Office of Research, the University Committee on Human Subjects or the University Committee on Animal Subjects.

Major Professor's Signature	Yvelyne Germain-McCarthy, Ph.D. (Printed Name)	February 16, 2009 (Date Of Exam)

I. I have read and approved this manuscript.

Committee Member's Signature	Richard B. Speaker, Jr., Ph.D. (Printed Name)
Committee Member's Signature	Patricia J. Austin, Ph.D. (Printed Name)
Committee Member's Signature	Claire A. Thoreson, Ph.D. (Printed Name)
Dean of the College	James Meza, Jr., Ph.D. (Printed Name)