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UNIVERSITY OF CALIFORNIA, SAN DIEGO
SAN DIEGO STATE UNIVERSITY

Sustaining Lesson Study: Resources and Factors that Support and Constrain
Mathematics Teachers' Ability to Continue After the Grant Ends

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

in
Mathematics and Science Education
by
Bridget Kinsella Druken

Committee in charge:

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Donna Ross

2015

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Chair

University of California, San Diego
San Diego State University
2015

DEDICATION

This dissertation is dedicated to mathematics teachers deepening their practice so that they may help all students learn mathematics.

To my parents, Valerie and Patrick, for their love.

EPIGRAPH

When one tugs at a single thing in nature,
(s)he finds it attached to the rest of the world.

John Muir

I've learned that people will forget what you said,
people will forget what you did,
but people will never forget how you made them feel.

Maya Angelou

Develop an interest in life as you see it;
the people, things, literature, music - the world is so rich,
simply throbbing with rich treasures, beautiful souls and interesting people.
Forget yourself.

Henry Miller

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- Druken, B. K., Fredenberg, M., & Nickerson, S. D. (2012). Hybrid lesson study:
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(Eds.), *Proceedings of the 34th Annual Meeting of the North American
Chapter of the International Group for the Psychology of Mathematics
Education* (pp. 1194), Kalamazoo, MI: Western Michigan University.

SELECT CONFERENCE PRESENTATIONS AND POSTERS

- Druken, B.K., & Nickerson, S.N. (2015, February). Conceptualizing sustainability and factors that support teachers continuing lesson study after infusion of external resources. Presentation conducted at the annual meeting of the *Association of Mathematics Teacher Educators*, Orlando, Florida.
- Druken, B.K. (2014, November). Conceptualizing sustainability with lesson study in U.S. after grant ends. Presentation at the annual meeting of the *World Association for Lesson Studies 2014 International Conference*, Bandung, Indonesia.
- Nickerson, S., Druken, B.K., & Fredenberg, M. (2013, September). Examining teacher roles during planning and debriefing sessions of lesson study in US mathematics teacher professional development. Presentation at the annual meeting of the *World Association for Lesson Studies 2013 International Conference*, Gothenburg, Sweden.
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ABSTRACT OF THE DISSERTATION

Sustaining Lesson Study: Resources and Factors that Support and Constrain
Mathematics Teachers' Ability to Continue After the Grant Ends

by

Bridget Kinsella Druken

Doctor of Philosophy in Mathematics and Science Education

University of California, San Diego, 2015

San Diego State University, 2015

Professor Susan Nickerson, Chair

Lesson study, a teacher-led vehicle for inquiring into teacher practice through creating, enacting, and reflecting on collaboratively designed research lessons, has been shown to improve mathematics teacher practice in the United States, such as improving knowledge about mathematics, changing teacher practice, and developing communities of teachers. Though it has been described as a sustainable form of professional development, little research exists on what might support teachers in continuing to engage in lesson study after a grant ends. This qualitative and multi-

case study investigates the sustainability of lesson study as mathematics teachers engage in a district scale-up lesson study professional experience after participating in a three-year California Mathematics Science Partnership (CaMSP) grant to improve algebraic instruction. To do so, I first provide a description of material (e.g. curricular materials and time), human (attending district trainings and interacting with mathematics coaches), and social (qualities like trust, shared values, common goals, and expectations developed through relationships with others) resources present in the context of two school districts as reported by participants. I then describe practices of lesson study reported to have continued. I also report on teachers' conceptions of what it means to engage in lesson study. I conclude by describing how these results suggest factors that supported and constrained teachers' in continuing lesson study.

To accomplish this work, I used qualitative methods of grounded theory informed by a modified sustainability framework on interview, survey, and case study data about teachers, principals, and Teachers on Special Assignment (TOSAs). Four cases were selected to show the varying levels of lesson study practices that continued past the conclusion of the grant. Analyses reveal varying levels of integration, linkage, and synergy among both formally and informally arranged groups of teachers. High levels of integration and linkage among groups of teachers supported them in sustaining lesson study practices. Groups of teachers with low levels of integration but with linked individuals sustained some level of practices, whereas teachers with low levels of integration and linkage constrained them in continuing lesson study at their site. Additionally, teachers' visions of lesson study and its uses shaped the types of

activities teachers engaged, with well-developed conceptions of lesson study supporting and limited visions constraining the ability to attract or align resources to continue lesson study practices. Principals' support, teacher autonomy, and cultures of collaboration or isolation were also factors that either supported or constrained teachers' ability to continue lesson study. These analyses provide practical implications on how to support mathematics teachers in continuing lesson study, and theoretical contributions on developing the construct of sustainability within mathematics education research.

Chapter 1: Introduction

If you want to destroy something in this life – be it acne, a blemish, or the human soul – all you need to do is surround it with thick walls. It will dry up inside. Now we all live in some kind of a social and cultural circle. We are born into some sort of nation, family, class. But if we have no connection with the worlds beyond the ones we take for granted, then we too run the risk of drying up inside.

- Elif Şafak, Turkish novelist

I feel so lost without the grant and without the conversations. And I just felt like such a better teacher when I was in the grant. Just ‘cause you, you had other people who wanted to talk about mathematics, and wanted to have all those conversations. And when you're doing it by yourself, I'm constantly questioning if what I'm doing is right.

- fourth grade teacher & mathematics coach, Carmen

The focus of this dissertation is on factors that supported and constrained practicing mathematics teachers' ability to continue to engage in lesson study. The setting is the first school year after a three-year partnership called Project X ended among 19 elementary, middle, and high schools across two districts and a large southwestern university. The design of the partnership to improve algebraic instruction included using lesson study four times each year, a one-week intensive institute each summer, and mathematics coaching throughout the school year. Participants of the current study included former Project X participants - teachers, mathematics coaches, site administrators like principals, and teachers on special assignment (TOSAs) like the co-investigator of Project X. I am interested in understanding: practices of lesson study that were reported to have sustained, the nature of conceptions on lesson study held by participants, and factors that supported and constrained mathematics teachers'

ability to continue to engage in lesson study as a form of professional development after external funding ended. The findings make important theoretical and practical contributions to mathematics teacher professional development in the areas of intersection among lesson study, sustainability, and mathematics teacher education.

The End of a Partnership and Beginning of Transition

I was first introduced to lesson study as a form of professional development for mathematics teachers while working as a research assistant for a California Mathematics and Science Partnership (CaMSP) called Project X. Approximately seventy-four teachers participated in four lesson studies per year for three years - two cycles per year as a full participant and two cycles observing and debriefing during their colleagues' lesson study cycles. It was there that I learned that lesson study, based on decades old Asian teaching practices, situates teacher learning in every-day teacher settings through the collaborative practices of planning, teaching, and debriefing mathematics lessons with a specific focus on student thinking.

During these years as a research assistant for Project X, I assisted in planning summer professional development activities, assisting teachers plan research lessons, observing the enactment of research lessons and participating in the debriefing of research lessons. I also collected and analyzed data like lesson plans, classroom videos, and observation notes and managed the online website that housed documents, videos, lesson plans, and online conversations. I became interested in teachers' planning and debriefing conversations that always seemed to entail rich discussions about teaching and learning mathematics. I also became interested in seeing if any of the teachers might continue past the end of the grant. Anecdotal conversations with

participants suggested that participants liked participating in lesson study for a variety of reasons. Yet others described how it would not be possible to continue.

I became curious about teachers' conceptions of lesson study along with whether some teachers would continue it. For if I wanted to continue working with lesson study teachers, they would have to want to and be able to continue it after the grant finished. Along with the co-investigators of the partnership, I designed a short-response survey towards the end of the grant to inquire about teachers' plans for continuing to implement lesson study in the upcoming 2013 – 2014 school year. Its purpose was two-fold: to gain insight into teachers' desire to continue and to help them think about next steps for continuing lesson study. On it, we asked Project X teachers with whom they might work, when they could work together, and what sort of time they would need to plan, observe, and debrief the research lesson. Approximately 75% of 80 teachers indicated that they would like to continue with lesson study. After analyzing results from this first survey, I followed up with those teachers who expressed interest in being contacted for a second survey in October 2013.

Of the twenty-six respondents of this second survey, I learned that eight (30%) responded yes and that they had completed one round of lesson study, four (15%) responded yes and that they had not completed one round of lesson study, 5 (19%) responded they had not but planned to, and two (7%) responded they did not plan to. Seven (27%) responded with "other", with responses including: they have continued with teachers at sites other than their own, they would like to but colleagues were not

open to it, they do not have time since their site is busy implementing Common Core State Standards, or they were not teaching math this year.

Respondents were asked to characterize the factors that supported or hindered lesson study. Factors that were reported to support lesson study included: 25% (7) reported that they had collaboration time for lesson study, 15% (4) reported arranging time after school to collaborate with others for lesson study, and 3% (1) selected that they utilized social media to collaborate virtually with others for lesson study. Factors that were reported to hinder lesson study included: 65% (17) reported they had a means to plan but no means to observe, 46% (12) reported collaboration time not geared for lesson study, 19% (5) reported a lack of resources to meet, 11% (3) reported a presence of resources but a lack of established culture for collaboration, and 3% (1) reported that they could plan and observe but were in need of other support. Eleven percent (3) selected “other,” and expanded to report that others did not want to participate and others did not value or favor lesson study. Further reports on factors that hindered lesson study in the comments section included: a lack of openness from their colleagues about lesson study, a lack of time to engage in lesson study, and a reassignment of teaching responsibilities to teach a subject other than mathematics. These preliminary results motivated me to inquire more into this context.

My research started with the initial question of “*Did* teachers sustain lesson study after external infusion of resources ended?” If it did sustain, then I planned to analyze factors that supported them in continuing, and if it did not sustain, then I planned to analyze factors that constrained them in continuing. I found Gamoran and colleagues’ use of the word *sustainability* helpful, which refers to maintaining

generative practices, with practices in this case referring to the investigation, planning, teaching, observing, and debriefing practices that together comprise lesson study. By studying which teachers worked together and the kinds of activities they engaged in, I could study teachers' practices to see if they sustained lesson study.

In beginning to analyze this question, I quickly found that I had to change the focus of my research question to, "*What* aspects about lesson study sustained after external infusion of resources ended?" With this new perspective, I present four different scenarios: those that engaged in a district-led effort to continue with lesson study and some lesson study practices, those that continued particular aspects of lesson study but not an 'official cycle', those that did not continue lesson study in any way, and those that engaged in teacher-led lesson study. Understanding these non-exclusive and prototypical cases and the factors that supported and constrained teachers in each form the basis of my inquiry and drive the rest of this study.

Determining What Sustained

Of those participants that responded to my May 2013 initial survey, eleven teachers reported having completed a cycle of lesson study between May and October 2013. These teachers participated in a district-led effort to continue lesson study, as described in the previous paragraph. When analyzing teachers' survey responses in greater depth, I discovered that the two districts involved in the partnership, Long Pond and Sun Valley school districts, each put some support structures in place to facilitate the continuation of lesson study. For example, Sun Valley put into place material resources, or time and curricular materials, like money raised by parent teacher groups to hire a Visual and Performing Arts (VAPA) teacher for teacher

collaboration time. Long Pond also hired a physical education teacher so that teachers within the same grade-level could collaborate. Both districts also used the human resource, or expertise from outside and within schools, that comes from interacting with mathematics coaches alongside mathematics teachers during the school year. I also learned through these survey responses that the district-led lesson study effort differed from the Project X lesson studies in what seemed like potentially important ways. For instance, teachers noted that they had less time to plan and research the lesson, as well as less time between creating the lesson and enacting the lesson.

Other teachers noted that they participated in an informal or incomplete lesson study by enacting aspects of a lesson study but not a full cycle like they experienced in the grant. This describes the second case of lesson study stated in the beginning of this chapter, aspects of lesson study. Teachers noted that they “kind of” did a lesson study or “informally we’ve done little pieces here and there.” One fifth-grade teacher specified that she completed components of lesson study rather than a full cycle: “Components, yes. Completion of a full beginning to end? No.” An eighth-grade resources specialist program (RSP) teacher noted that she did not do a lesson study “like we did during the grant.” She targeted the practices of anticipating student thinking and responding to student with particular questions to indicate that she had continued aspects of lesson study.

We don't fill out the forms and do all that stuff. But we certainly, it certainly in the back of my mind when I'm planning a lesson. Like, what I'm going to say and questions I'm going to ask and anticipating what they're going to say. So it's in the back of my

mind, but we don't write it like scripted out like we did during the grant.

The third case identifies an isolated teacher at a middle school who did not engage in lesson study the year following the end of Project X. Seventh-grade mathematics teacher, Tonya, was at a site and district that recently *removed* collaboration time from teachers' contract due to fiscal issues of bussing students. Tonya was one of two seventh-grade mathematics teachers at her site, and the only one interested in collaborating on instruction. Although she participated in the district-led lesson study during the beginning of the year and attempted to bring teachers at her site together for another cycle of lesson study, she had no success with her efforts.

Finally, one group of teachers in Sun Valley reported that they used lesson study as a way to meet goals about Common Core with their site. They engaged their entire school teaching staff in a site-wide lesson study after one of their leadership team meetings. These teachers fall into the category of a teacher-led site-wide lesson study. Their goal was to learn more about particular Common Core Standards in language arts through lesson study. I was able to watch the enactment and debriefing of the fifth grade teachers' collaboratively planned lesson that targeted the new Common Core Standards in language arts using the context of planets. When asked how it happened that all teachers at their site engaged in lesson study, without each teacher having lesson study experience, fifth grade teacher and participant for this study Kerry stated that two teachers suggested it and then the leadership team supported the idea.

At each meeting, we [teachers of a site-wide leadership team participating in a district training with other leadership teams] had to come up with an action plan for what we would accomplish the next time. And it was kind of spontaneous. I suggested it; someone else at the table suggested that we would try some lesson study! [hooks arm and smiles] And the principal was very excited that we wanted to do it. And she went to the district and got them to pay for the subs so that we could do that.

All three of these fifth-grade teachers had lesson study training, two from Project X and one teacher from the grant prior to Project X called Siesmic. Further, these teachers described successfully educating their principal on what lesson study is and that they could in fact design a lesson that targeted language arts standards using the context of planets. A sense of autonomy permeated the teacher collaborations at this site.

Given (a) the Project X teachers' expressed desire to continue in survey data, (b) some supports put in place by districts like hiring VAPA and PE teachers to allow for weekly teacher collaboration, and (c) some completion of lesson study, I wondered why some teachers were continuing while others were not. This situation motivated the beginning of my work that I present here in this dissertation.

Why Lesson Study for the Professional Development of Mathematics Teachers?

Another reason for this study is the increasing use of lesson study for professional development. A growing number of recent studies have shown that lesson study, a teacher-led professional development situated in teachers every day professional experiences, has the potential to offer rich opportunities for the learning and teaching of mathematics (c.f., Alston, Pedrick, Morris, & Basu, 2011; Fernandez, 2005; Lewis, Perry, & Hurd, 2009; Murata et al., 2012; Yoshida, 2012). As Stigler and

Hiebert (1999) noted, Japanese teaching practices, which include lesson study among others, focus on “clear learning goals for students, a shared curriculum, the support of administrators, and the hard work of teachers striving to make gradual improvements in their practice” (p. 109) with no assumptions that a teacher’s learning stops after their teacher-training program ends. Referred to as “the linchpin of the improvement process,” (Stigler & Hiebert, 1999, p. 111) lesson study has been praised to hold great promise for improving teacher learning and student learning.

Stigler and Hiebert (1999) summarize succinctly the reasons why teachers and administrators would want to participate in lesson studies as a form of professional development.

If you want to improve teaching, the most effective place to do so is in the context of a classroom lesson. If you start with lessons, the problem of how to apply research findings in the classroom disappears. The improvements are devised within the classroom in the first place. The challenge now becomes that of identifying the kinds of changes that will improve student learning in the classroom and, once the changes are identified, of sharing this knowledge with other teachers who face similar problems, or share similar goals, in the classroom (p. 111).

Using the context of the classroom with a focus on lessons helps to improve teaching effectively with little translation from research to practice needed, leaving room for a collective focus on student learning.

The process of lesson study involves teachers collaboratively (a) *investigating* content and setting goals for the research lesson, both content-focused and broader site based goals, (b) *planning* a research lesson that seeks to inquire into how students learn a particular topic or sets of topics; (c) *teaching* and *observing* a live research

lesson while gathering student data; and (d) finally, *debriefing* on specifics of what was learned from the lesson as well as more generally about teaching and learning mathematics (Fernandez & Yoshida, 2005; Lewis & Perry, 2014; Lewis, Perry, & Hurd, 2009). Optionally, teachers may modify their research lesson and choose to teach it a second time, collecting data on student thinking and debriefing again. I refer to this process, whether or not a second teaching occurs, as one cycle of lesson study. I refer to this process, described as “study-plan-do-reflect” by Lewis & Perry (2014), as one cycle of Japanese lesson study.

Yoshida (2012), whose dissertation and work with the Trends in International Mathematics and Science Study (TIMSS) helped to spread the idea of lesson study in the United States in the 1990s, summarized how quality and effective lesson study in mathematics has helped teachers improve their practice. Lesson study as been shown to “enhance their [teachers] content knowledge and pedagogical content knowledge to improve instruction in classrooms, develop good ‘eyes’ to see and analyze student learning, and ultimately to produce better student learning” (p. 141). More specifically, lesson study has potential to enhance teachers’ knowledge about mathematics content (Alston, Pedrick, Morris, & Basu, 2011; Fernandez, 2009; Knapp, Bomer & Moore, 2011; Lewis & Perry, 2014; Lewis, Perry, & Hurd, 2009; Meyer & Wilkerson, 2011; Robinson & Leikin, 2012; Yoshida 2012), change teaching practice (Hart & Carriere, 2011; Murata, Bofferding, Pothen, Taylor & Wischnia, 2012; Olson, White & Sparrow, 2011), nurture professional communities of teachers (Lieberman, 2009; Lewis, Perry & Hurd, 2009; Saito, Khong & Tsukui, 2012), and assist in understanding implications of reform movements (Lee & Ling, 2013; Lewis

& Takahashi, 2013). These four foci – enhancing mathematical content knowledge, changing teachers’ practice, nurturing professional communities, and helping understand implications of reform movements – are all ways in which lesson study has contributed to the improvement of learning and teaching mathematics.

While lesson study has become increasingly popular in the U.S. since the publication of a dissertation (Yoshida, 1999) and *The Teaching Gap* (Stigler and Hiebert, 1999) in the mid 1990s, relatively little research exists concerning reasons that teachers continue lesson study after the infusion of external resources ends (Lewis & Perry, 2014; Saito, Khong, Tsuki, 2013). A small amount of research points to a number of factors that support the continuing of lesson study (Gero, 2015). Indeed, there is some evidence of lesson study groups continuing for years (Lewis, Perry, Hurd, & O’Connell, 2006). Similarly, relatively few research studies address factors that support and constrain the continuing of lesson study (Fujii, 2013).

Researchers interested in lesson study as a vehicle for professional development call for more research on lesson study to move the mathematics education field forward (Fernandez, 2005; Lewis, Perry & Murata, 2006). Many articles suggest that lesson study to be a sustainable professional development effort. Yet as Lewis, Perry, and Hurd (2009) concluded, more lesson studies and over longer periods of time are necessary to learn more about supporting teachers’ improvement of practice. “Whether or not the small changes seen in this case will add up to long-term change in teaching culture cannot be judged from a single cycle of lesson study” (p. 302). My work contributes a mixed methods study that examines in depth what might be needed to sustain lesson study efforts of teachers who recently engaged in lesson

study.

Why Social Resources?

Participating in lesson study requires a considerable alignment of resources due in part because it involves collaboration among teachers and other educators, such as mathematics coaches and principals, while planning, teaching, and debriefing a research lesson. These resources could include *material resources* (time, information like curriculum or activities, and physical objects), *human resources* (qualities of people that can be changed, like training someone to be a mathematics coach), and *social resources* (attributes of relationships, roles or modes of communication like connections to mathematics coaches and other people) (Gamoran, 2003).

Yet little research addresses what types of social resources are needed to sustain lesson study (e.g. Lewis & Perry, 2014). Understanding how social resources are part of institutional settings of teachers could help to better understand what supports teachers in continuing lesson study and other similarly related professional development efforts in general (Gamoran et al., 2003). I found that analyzing survey, interview, and field note data with respect to social relationships described by my participants to be important for two reasons. One, lesson study by its very nature is a collaborative endeavor. If teachers would like to continue with lesson study, teachers necessarily will need other teachers to meet the basic requirements of lesson study – planning a lesson, observing and teaching the lesson, and debriefing on collected data, the lesson, and teaching mathematics in general. Two, it was apparent early on in the resource analysis that just providing material and human resources was not sufficient for most teachers to engage in lesson study. Many teachers described difficulties in

finding other teachers interested in engaging in lesson study, with a desire to inquire into their profession. Gamoran and colleagues' (2003) framework on sustainability focused on social resources within groups and institutions. If I was interested in answering my research questions and contributing to the field about sustainability, then I would need to focus on relationships among individuals in addition to qualities of individuals or the context that the district and teachers sat in.

Consequently, the major focus of this study was to understand the social resources embedded in the institutional settings such as classrooms, school sites, and districts that teachers work in (Cobb, McClain, Lamberg, & Dean, 2003). In these institutional settings, teachers could be seen as members of a number of groups, some formally arranged by the school or district with others informally arranged by the teachers themselves (Kramer, 2003). Research points to the importance of these professional communities of practitioners within institutional settings (c.f., Cobb, Zhao, & Dean, 2009; Grossman, Wineburg, & Woolworth, 2001; Nickerson & Moriarty, 2005), with lesson study being one way to develop a professional community of teachers who inquire collectively into student thinking (Yoshida, 2012). Attending to how teachers are embedded in institutional settings and the groups that they are members of could help lesson study researchers better understand how schools and districts shape the activities, learning, and goals of teachers within them.

To understand how social capital is embedded in groups among complex institutional settings, I use a modified version of Gamoran and colleagues' sustainability framework that focused on social relations within groups and between these groups and the institutional settings. Inspired by Woolcock's (1998) framework

for conditions for sustainability of economic development efforts, Gamoran and colleagues applied Woolcock's framework to the educational context of teaching mathematics and science for understanding. As mentioned previously, I use their conceptualization of sustainability of maintaining the generative practices of lesson study (investigating, planning, teaching, observing, and debriefing). Gamoran and colleagues cited the work of Franke and colleagues (2001) as foundational to their conceptualization of sustainability.

Generativity means not only maintaining new practices over time, but modifying and adapting practices continually, in response to new learning and reflection that occur as a result of persistent focus on student thinking (p. 174).

Gamoran and colleagues' (2003) framework for sustainability centers on four components: integration, linkage, organizational integrity, and synergy. *Integration* refers to shared values, mutual expectations, levels of trust, and norms. *Linkage* refers to the social relations that attract resources. *Organizational integrity* refers to the effectiveness of the organization in distributing human and material resources. Finally, *synergy* refers to whether the efforts of the teacher community are aligned with the efforts of the school and district. One can imagine integration as intra-community ties and linkage as extra-community ties on a micro or group level, and synergy as relations between communities and the institution and organizational integrity as coherence and capacity of the institution on a macro or institution level. For reasons that will be further elaborated in Chapters 2 and 3, I use a modified version of this framework by focusing on integration, linkage, and synergy in an effort

to understand factors that supported and constrained teachers' ability to continue lesson study.

Resources Provided Within Two Districts

The two districts in the current study, Long Pond and Sun Valley, offered varying levels of support for continuing lesson study during the first year after the end of the grant. Though a full description of these resources rest in the first part of Chapter 4 results, I provide an overview on how each district found ways to provide access to material, human, and social resources.

Both districts provided most teachers with approximately 50 minutes each week to collaborate in their grade-level bands of teachers, with the exception of middle schools in Long Pond, with professional learning community (PLC) time. PLCs have the potential to support lesson study by: providing the material resource of time needed for teachers to investigate and plan a research lesson, develop human resources about lesson study through interacting with a mathematics coach and other teachers, and finally, providing connections to people that can attract other resources.

Another human resource provided by both districts were Teachers on Special Assignment (TOSAs) coaches. TOSAs were former teachers (some former Project X participants) hired by the district to provide support and professional development to teachers as they learned about the implementation of the Common Core State Standards (CCSS). TOSAs often worked at teachers' sites, facilitated professional development at the district office, and taught classes (both inconsistently when the opportunity arose and consistently as part of their work responsibilities). These TOSA coaches had the potential to support lesson study by providing material, human, and

social resources, such as teaching a lesson study teacher's class so that they could work with other teachers, leading workshops on how to engage in lesson study, and providing support as an outside observer on the research lesson day, respectively. There was least one TOSA in each district that participated in Project X as a mathematics coach, during which time they engaged in training with the co-investigator of the grant and former eighth-grade mathematics teacher, Kimmy, on how to provide support to teachers as a mathematics coach.

Other material resources provided by districts included the hiring of physical education (PE) teachers or visual and performing arts teacher for the 2013-2014 school year so that all teachers in a particular grade-level could collaborate together, offering to pay teachers three hours for professional development to use during the school year outside of contracted hours at their own discretion, providing teachers one-day paid professional development day twice a year, the willingness from some principals and vice-principals to cover classes while teachers collaborated together on a research lesson, as well as curricular material, conceivably like the CCSS framework, textbooks, and some teacher-designed end-of-unit assessments. These physical, human, and social resources show much promise in supporting the lesson study groups to continue the work started by three years of engaging in lesson study as part of a grant.

Social Relationships Among Teachers

As mentioned previously, I interviewed those teachers who expressed an interest via an online survey to further probe their survey answers and ask tailored follow-up questions about with which teachers they work, the activities they engage

in, resources that support their teaching, and questions about lesson study. I also interviewed other teachers identified as playing an important role in their collaborations, the principal of some teachers, and former mathematics coaches whose new position was at the district office at the time of data collection. Together these different perspectives would help me to learn about teacher collaboration, triangulate my findings, and add depth to the data I collected.

Working with teachers across sites and districts during Project X helped to forge professional relationships among teachers, principals, and district administrators that did not exist prior to the grant. Not surprisingly, I discovered in my interviews that participants often named specific colleagues when describing with whom they collaborated and the activities they did together. They also explicitly and sometimes implicitly described to what extent these teachers' goals and expectations about collaboration aligned or did not align. Teachers described shifting relationships in part due to teachers were no longer working with the same teachers that they worked with during the Project X grant. Additionally, teachers described working during a time when each district was focused on implementing the CCSS.

It became clear to me that these social relationships – goals and values of a group, the links to other people, resources, or groups, and the extent to which their goals aligned with the district – played a role in shaping teacher collaboration. It also became clear to me that the social relationships varied in nature and across groups, with interactions among teachers not limited to their grade-level groups. I hypothesized that these social relationships could have important consequences in determining whether lesson study cycles occur. To find a way to analyze the nature of

these social relationships, I turned social network theory to begin to untangle this complex setting.

To account for these social resources among teacher and district administrators in a systematic way based on empirical data, I turned to social network theory analysis. Carolan (2014) describes four distinguishing features of social network analysis: (1) a strong focus on structure, or the embedded patterns of relations within and between groups, (2) a systematic collection and analysis of empirical data, (3) graphical imagery as an important tool, and (4) mathematical models to obtain high levels of objectivity. Given my strong interest in and Master's work on graph theory as well as the context of my study, I decided that social network theory analysis would prove powerful in guiding my research. That is, social network theory analyses would help me learn about the embedded patterns of relations within and between groups to better understand issues of sustainability of lesson study.

I chose my three research questions to help me understand what supported and constrained teachers' ability to continue lesson study. The three research questions motivating this study are the following:

1. What practices of lesson study continued after the grant ended?
2. What are teachers' conceptions of what it means to engage in lesson study?
3. What factors supported or constrained teachers' ability to continue lesson study?

To explain why I chose to inquire with the guidance of these three questions, I return to the teachers of this study.

RQ 1: What Practices Sustained?

As mentioned in the beginning of this chapter, from my interviews, survey data, and field notes, I found four initial responses to my research question that sought to understand what practices of lesson study, if any, continued past the formal conclusion of the grant. I found a range of different answers. Some teachers reported engaging in a district-led lesson study effort. Some reported continuing aspects of lesson study while recognizing that they did not complete a full lesson study cycle. Others reported not continuing lesson study at their site, while some engaged in a teacher-led lesson study effort with their site. Understanding what sorts of resources supported each of these situations will give insight to supporting (and constraining) varying levels of continuing a particular professional development effort.

RQ 2: Participants' Conceptions of Lesson Study

In addition to a difference in what sustained about lesson study among participants, in my interviews I noticed similarities and differences in teachers' descriptions about nature of lesson study. Some participant teachers characterized lesson study as one activity in addition to an already too long list of teaching responsibilities. For instance, upper elementary teacher Layla suggested a view of lesson study as separate from her other responsibilities as a teacher. "What is the expectation of lesson study, that you would do it for everything [all lessons]?" Layla's response suggested a view of lesson study as unreasonable because it took too much time, in addition to her other teaching responsibilities. In contrast, other teachers described lesson study as a vehicle that could be used to connect and address multiple teaching responsibilities in a productive way. Fifth-grade teacher and former Project X mathematics coach Ben stated, "Lesson study provides a structure, a matrix so to

speak, on how to do things in the classroom with your colleagues.” He expressed an interest to use lesson study in conjunction with the implementation of the Common Core State Standards. He described having a conversation with his principal where he told him that, “If you do lesson study you've got your professional development, you've got your collaboration, you've got your curriculum designing. You have all these different facets that lesson study has as a structure on how to do this.”

These conversations with teachers made me wonder about what it meant to engage in lesson study from teachers’ perspective. More specifically, given the ways that teachers referred to lesson study, with some describing it as a separate activity while others describing it as dovetailing with the duties of a professional teacher, made me wonder what other conceptions of lesson study teachers held. If teachers held one conception of lesson study, would they be more or less likely to engage in lesson study than others? What other conceptions held by teachers might be related to their ability to continue to engage in lesson study after the grant ended? These questions led to my second research question regarding what teachers’ conceptions of lesson study?

RQ 3: Factors that Support and Constrain Lesson Study

I was also interested in analyzing interview and survey data for factors that would support or constrain teachers’ ability to continue lesson study. It came as no surprise that many teachers responded that they would need more time to engage in lesson study, or that they would need resources that support teachers in engaging in lesson study like textbooks to develop lessons or manipulatives to guide particular

mathematical activities. Other teachers described needing an expert to facilitate teachers while engaging in lesson study.

But then teachers began to describe other important factors that had not occurred to me before the start of my research, like other teachers' support because teachers could not "rally forces" on their own. Others stated that they needed support of the principal so that their lessons and teaching styles could be supported, and so that teachers could have enough material resources, like time and money, to request a substitute teacher. Or, as in some cases, having principal support could mean that the principal could cover a teacher's class during components of lesson study. Some indicated that having a collaboration time during a particular time of the day would be needed so that teachers could teach, debrief, then teach again during the same school day. Some teachers noted that the union shaped their group's ability (or lack of ability) to continue lesson study.

This issues in part brought to mind a greater theme that seemed to play an role in supporting teachers' in continuing lesson study – the alignment (or misalignment) of teachers' goals within groups of teachers. If teacher goals were not aligned, then engaging in lesson study could prove challenging if groups of teachers had similar goals but different ways of reaching those goals. Additionally, interviewing principals of teacher participants in my study allowed me to see an even more complex and intricate picture as principals often control resources (DuFour, 2004). Principals described being aware of how their position of power might affect teachers in both favorable and unfavorable ways.

Summary of Research Questions

Together, my experiences wondering about practices of lesson study reported to have continued, teachers' conceptions of lesson study, and factors that supported or constrained teachers' ability to continue lesson study led to my interest in better understanding the complex institutional context within which teachers, principals, and district administrators worked. My research design combines qualitative and quantitative methods of analysis. Primary data sources include multiple choice and short response online surveys; semi-structured, tailored interviews with teachers, site administrators such as principals, and TOSAs like the former grant co-investigator; and field notes from some teacher meetings. The semi-structured and tailored follow-up interviews ranged in length from 35 minutes to 60 minutes in length. Though 32 teachers and 6 principals and district administrators were interviewed for the study, I selected four cases involving 17 participants to show the prototypical range of situations that occurred.

Transcribed interview data were analyzed using three methods. First, data were analyzed using grounded theory methods of open coding, axial coding, and the constant comparison to derive codes from empirical data with research questions used to direct my focus (Corbin & Strauss, 1990). Second, social network data were inferred from interview and survey data and used to support qualitative analyses (Carolan, 2013; Daly, 2014). This involved finding networks of participants who expressed professional relationships with others using an egocentric social network approach. Third, data were analyzed using case study and multiple case study analyses (Stake, 1995, 2006; Yin, 2008).

Importance of Research Questions

My work examines social resources embedded in institutional setting that support and constrain lesson study efforts in schools and districts as teachers get reorganized when relationships among teachers shift. Theoretically, this study encourages thinking about whether sustainability à la Woolcock's (1998) sustainability model is appropriate in the context of lesson study for mathematics teachers. It also considers how to define sustainability with the lesson study context. For instance, rather than asking if lesson study continued, asking what aspects of lesson study continued might be more productive. Practically, this study suggests factors that might support or constrain the potential for lesson study to continue after support from grants end that could be used by mathematics coaches, administrators, and professional developers. For instance, those supporting teachers in lesson study could consider social resources, like connections to others in their network, whether teachers' goals and values align, or what teachers' conceptions of lesson study are, when designing, modifying, or continuing lesson study.

This work is important for a number of reasons. First, this study will add to the dearth of literature on how teachers, principals, and district administrators can work towards supporting continued practice of lesson study in schools. My work gives detailed qualitative and quantitative analyses of factors supporting or constraining the continuation of lesson study after grant funding ends with four cases. This has important implication for how those supporting teachers in lesson study could consider social resources, like connections to others in their network, whether teachers' goals and values align, or what teachers' conceptions of lesson study are, when designing,

modifying, or continuing lesson study. Additionally, knowledge about teachers' conceptions of lesson study could help teachers, principals, and district administrators training teachers on lesson study. For instance, facilitators of lesson study might create opportunities for discussions that focus participants' attention on how they could continue their work when the context shifts. This could align teachers' expectations, that lesson study is a vehicle for professional development rather than a method to create expert lessons, and make the prospect of continuing lesson study more likely.

Second, results from this study encourage those supporting and researching lesson study to think deeply about ways in which they hope to sustain professional development efforts after the life of a grant. What aspects of the grant are desired to continue past the grant, and how will these aspects be gauged? Rather than answer the question of whether lesson study (or another teacher-led, practice-based form of professional development) sustained, those supporting and researching lesson study could ask what aspects of the professional development experience sustained to better understand how teachers continue what they learned.

Lastly, the theoretical focus on sustainability and social network theories using four case study analyses along with grounded theory techniques will strengthen research on mathematics teachers and lesson study. Currently, few studies in mathematics education exist that utilize social network theories, sustainability frameworks, and the lesson study theoretical model. Detailing the strengths and weaknesses of each of these frameworks will provide footholds for other researchers to expand on these theoretical and conceptual tools in ways productive for their contexts and purposes.

Summary

My work extends current research on mathematics lesson study by providing a better understanding on factors that support and constrain teachers' ability to continue lesson study when external funding ends. The unique study setting that follows up with participants that had over three years of lesson study experience examines resources in district settings, particularly social resources, to understand conceptions of lesson study, practices that sustained, and factors that both supported and constrained teachers in continuing lesson study. I did this by collecting survey, interview, and social network data, analyzing it with a modified sustainability framework (Gamoran et al., 2003), and reporting results using case studies analyses.

In Chapter 2, I present research that supports my work by elaborating my theoretical framework and discussing relevant literature on current lesson study efforts for teachers of mathematics, sustainability of professional development efforts, and research on social network analyses. In Chapter 3, I describe the setting, data corpus, and methods of analysis. In Chapter 4, the first of my four results chapters, I report on the types of resources described by participants. In Chapter 5, I expand on social resources reported in Chapter 4 using a modified version of Gamoran and colleagues' (2003) framework for sustainability. In Chapter 6, I present results about practices of lesson study reported to have sustained. In Chapter 7, I report on teachers' conceptions of lesson study. I conclude with Chapter 8, where I summarize findings and connect implications back to the literature, discuss limitations of the current study, suggest implications of this work, and describe future work that builds from the current study.

Chapter 2: Review of Literature

This literature review is organized in two sections. The first briefly describes the general theoretical perspective that informs the proposed study, including a focus on social learning theories, communities of teachers, resources that support teachers' work, and sustainability in mathematics education research. The second section describes lesson study and research about its uses for teacher learning in mathematics.

Theoretical Perspective

The theory for my study is guided by three general perspectives, namely that (1) learning occurs by participation with a culture of particular norms, discourse, and other tools, (2) the institutional setting is important to consider when trying to understand actors in any setting, and (3) organizational resources both enable and constrain the activities of a group. In the following paragraphs, I expand on each of these perspectives.

Social Learning Theories

In general, a sociocultural perspective on learning refers to the social nature of learning in a particular setting or context that involves interactions between learners, more knowledgeable others, tools, and signs. The classic Vygotskian perspective on socioculturalism refers to the ideas of Russian psychologist Vygotsky, described as one of the fathers of the sociocultural perspective on learning, and developed by some of his followers, like Wertsch and Leont'ev (Forman, 2003; Goos, 2004; Staples, 2007; Vygotsky, 1963). In particular, the situated perspective posits that contexts help to create knowledge through activity within these situations (Boaler, 1998; Brown,

Collins, & Duguid, 1989; Goodwin, 1994). Under this perspective, learning can be viewed as enculturation into a community of practice, or as increased participation in a community of practice (Lave and Wenger, 1991; Sfard, 1998).

Lave and Wenger (1991) discuss learning as gradual participation in a particular community of practice that has associated to it certain activities, ways of participating, and artifacts. Not just any group of people constitute a community of practice. Wenger (1998) described three dimensions of a community of practice, which I exemplify with examples with respect to teaching: (a) a joint enterprise, or a shared vision among teachers, such as ensuring students reason mathematically when using manipulatives and diagrams, (b) mutual engagement, or general and mathematics specific norms or ways of interacting like having students use manipulatives or a diagram as constituting a justification, and (c) a shared repertoire for reasoning with tools and artifacts, like teachers referring to the same resource, like the material resource of a textbook, when designing lessons. A joint enterprise helps to ensure mutual accountability among the members of the community, and not just remain a stated goal, and is continuously negotiated by the community. Mutual engagement refers to the ways of relating of community members. It is a source of coherence but does not imply homogeneity. A shared repertoire for reasoning with tools and artifacts is used by a community in pursuit of their shared enterprise.

For my study, I drew from situated cognition, a perspective that views learning as enculturation into a practice where teachers develop “through a learning process in which teachers and others grow into the practices in which they engage”, often through professional communities of teachers.

Communities

Important to the sociocultural view of learning is attention to communities of teachers. Research on communities of teachers range in the way they define what constitutes a group. In a review on professional learning communities, Stoll and colleagues (2006) described definitions of professional learning communities. There is no universal definition of a professional learning community (PLC), Stoll and colleagues (2006) described broad consensus that a PLC is “a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way (Mitchell & Sackney, 2000; Toole & Louis, 2002); operating as a collective enterprise (King & Newmann, 2001)” (p. 223). I follow Westheimer’s (1999) definition of a community that highlighted five of the most common features identified by contemporary theorists interested in community:

- (a) shared beliefs and understandings, such as “a collective perspective, agreed-upon definitions, and some agreement about values”;
- (b) interaction and participation, such as “interpersonal contact and communication within community”;
- (c) interdependence, such as those practices that nurture “reciprocity and mutual need”;
- (d) concern for individual and minority views, like views of those who disagree; and
- (e) meaningful relationships, like a sense of connection and purpose (p. 74-75).

Teachers in my study were members of groups called “professional learning communities” (PLCs) where teachers in similar grade levels or grade level bands come together to discuss issues of instruction, such as assessments for the newly-

adopted Common Core Standards or professional development.

Practices of these communities are situated within groups that are embedded in institutional/organizational settings. Cobb, McClain, Lamberg, & Dean, (2003) noted that teaching occurs within institution settings like classrooms, school sites, and districts and that it is profoundly influenced by constraints of the setting, forms of assistance teachers that teachers draw on, and also resources that support their instructional practices. Additionally, teachers are often members of multiple groups, some formally arranged by the school or district and others informally arranged by the teachers themselves (Krainer, 2003). The ways and degree to which these groups are supported by schools and school districts have the potential to shape the activities, learning and goals of those within the groups (c.f., Cobb et al., 2003; Cohen, 1999; Nickerson & Moriarty, 2005). Understanding the supports that sustain teachers' professional communities for lesson study as they are situated within and constituted by institutional settings forms the foundation for how I understood the complexities in teaching.

Furthermore, a review of the lesson study research showed a relatively small number of studies that make explicit their theoretical groundings as rooted in sociocultural ideas. As will be shown, much of the research is cognitively based, such as what teachers learn from lesson study. This study pays close attention to the theoretical framework that guides analyses so that it may contribute clarity to future lesson study researchers interested in moving the field forward.

Researchers argue for models of professional development that develop communities of teachers (Sowder, 2007; Louks-Hordsely, 2012) and are grounded in

the practices of teaching (Ball & Cohen, 1999; Borko, 2004). More specifically, the field of mathematics education research recognizes the importance of professional communities of practice within the teaching profession (Cobb, Zhao & Dea, 2009). Researchers suggest that teachers' participation in strong professional networks and teaching communities "can be important social resources as teachers attempt to develop demanding instructional practices" that align with reform mathematics teaching (Cobb, Zhao & Dea, 2009, p. 167).

Many who study the professional development of mathematics teachers would agree that establishing communities of practice can have a positive effect on teacher learning and student achievement (Nickerson & Moriarty, 2005; Sowder, 2007). Yet, "establishing such a community is not at all easy, and maintaining the community is difficult, particularly because teachers move in and out of the school" (Sowder, 2007, 191).

Resources

Sustaining teaching for understanding and the professional development experiences that support this work requires effort and support from many people and in a variety of forms. Researchers argue that resources and access to them matter for supporting and developing teaching for understanding (Gamoran, 2003; Gamoran & Anderson, 2003). In their volume on supporting change in mathematics and science teaching, Gamoran and Anderson (2003) described their dynamic and multidirectional model for understanding organizational change to include a focus on groups, practices, and organizational resources. Organizational resources that both enable and constrain

activities of a group are three types of resources: (a) material, (b) human, and (c) social resources. (Anderson, 2003, p. 15).

Material resources refer to items that can be purchased or exchanged (Gamoran & Anderson, 2003). “They include money and anything money can buy, electronic information, and physical objects and structures”(p. 26). Common material resources for teacher collaboration include time for collaboration and curricular materials. *Human* resources refer to qualities of humans that can be exchanged among groups of people by people sharing memberships in each group. “When members of one group participate in the activities of another, they make their knowledge, skills, and commitments available to the members of the other group” (pp. 26-27). Common human resources include knowledge of curricula, knowledge of new standards, and knowledge of mathematical concepts that could be provided by a principal to a teacher. Other qualities of humans include understanding of students, knowledge of mathematical practices, and knowledge of cultural and social aspects of groups of students in a class.

Finally *social* resources include attributes of roles and relationships among members. These include shared values, shared expectations, norms, and trust. Social resources are built and maintained through networks of relationships among people. Whereas human resources refers to the skills and knowledge that one can learn, social resources refers to the qualities that facilitate the learning of skills and knowledge. Of particular interest for this study is understanding this third type of support, social resources, in the context of sustaining lesson study after external funding ends. Sustaining teaching for improving student learning and teachers’ mathematical

knowledge for teaching through the use of lesson study, a student and teacher centered form of professional development, forms the basis for my study.

Akiba et al. (2015) reported on survey results from district administrator from 85% of Florida school districts and found lesson study to be a major professional development being promoted in a majority of districts surveyed. Yet they also noted that limited levels of resources were allocated to engage teachers in lesson study. These results help to show that resources are important for supporting lesson study. As Gamoran (2003)'s work reminds us, we must ask not whether resources matter but *how* resources can be used in productive ways that benefit teaching and learning. "What matters most is not the dollar amount, but how dollars are translated into the capacity to support teaching for understanding" (p. 65).

Sustainability Framework

There are different ways to conceptualize sustainability. For instance, Fullan (2005) described eight elements of sustainability in the educational context to include: public service that has moral purpose, commitment to changing contexts at all levels, lateral capacity building through networks, intelligent accountability and vertical relationships, deep learning, dual commitment to short-term and long-term results, cyclical energizing, and the long lever of leadership (p. 14). Anderson (2003) describes *sustaining teaching for understanding* as requiring collective as well as individual efforts, depending on interdependence and not independence, and depending on leadership of professional communities. Collective effort refers to having support of colleagues and access to new and relevant developments. Interdependence refers to the need for professional communities to be integrated into

appropriate networks of colleagues and institutions that trade resources for a mutual benefit. “Thus, the key question is whether the exchange of resources can be sustained, not whether the community can continue without outside resources” (Anderson, 2003, p. 19). In other words, to sustain one must not ask whether a community can continue with a lack of resources, but instead ask if an exchange of resources, be it what they are, can be continued. Leadership of communities refers to a set of functions filled by different people rather than roles assigned to different people.

Defining sustainability.

Gamoran, Anderson & Williams (2003) conceptualize sustainability as they studied the potential of six case studies of professional development experiences for mathematics and science to self-sustain. They describe *sustainability* as maintaining generative practice, which are those practices teachers learn in their professional development experiences, and cite the work of Franke and colleagues (2001) as foundational. "Generativity means not only maintaining new practices over time, but modifying and adapting practices continually, in response to new learning and reflection that occur as a result of persistent focus on student thinking" (p. 174). In my study, the teaching practices are those that help achieve the goals of improving student learning as well as improving teachers' mathematical knowledge for teaching. Gamoran and his colleagues also use the work of Woolcock (1997) in social capital and economic development for examining potential for sustainability.

Framework for sustainability.

According to Woolcock (1997), four conditions for sustainability include: (a) integration, (b) linkage, (c) organizational integrity, and (d) synergy. *Integration* refers

to “trust, mutual expectations, shared values, and the potential for establishing norms within a community” (Gamoran, Anderson & Williams, 2003, p. 175). In other words, it is the alignment of expectations and values in a trusting environment that leads to community norms. An example of integration is the existence of common goals or shared visions among members. Integration is important because it provides the opportunity for collaboration among community members, in addition to common goals. *Linkage* refers to social relations to the environment outside the community that attract material and human resources for continued growth. As Gamoran and colleagues without linkage a group “may be cut off from its environment, preventing members from maintaining the resource flows necessary for sustained growth and diffusion” (p. 176). The authors note that it is not so much the relationship of the linkage but instead the community’s ability to provide something valuable in exchange to the outside environment. To understand linkage, one might ask if there are strong social ties between the professional community and key figures outside of the professional community. See Table X for the four conditions for sustainability.

Organizational integrity is described as the ability for an institution to manage the change process in a coherent and competent way. For instance, administrators need to be responsive rather than rigid when it comes to adhering to policies. Another way for a system to have organizational integrity is to have human and material resources, and be effective at distributing these resources among teachers. Human resources are defined as qualities of people that are shared among groups of people by overlapping membership. Participating in activities of one group allows a person to make available their knowledge, skills and commitments to other group members. One could ask the

following question to understand organizational integrity: “is the school system well resourced and well organized, with the ability to mobilize internal advocates and external experts to support a process of change?” (p. 178)

Table 2-1. Gamoran and colleagues’ (2003) conditions for sustainability based off of Woolcock’s (1998) model for economic development.

	Condition for Sustainability	Definition
Micro Level	Integration	“trust, mutual expectations, shared values, and potential for establishing norms” in community -focusing collectively on common goals
	Linkage	social relations that attract resources -cut off from environment? -resources obtained through social relations depend on whether that group has something to provide in exchange -influence on policy and supportive professional development
Macro Level	Organizational Integrity	effectiveness of the organization in distributing human and material resources coherence, competence, and capacity of institutions to manage a process of change -responsive not rigid -good at acquiring material and human resources -system for deploying resources strategically -internal structure providing capacity, credibility, and flexibility to sustain meaningful change
	Synergy	alignment of efforts of teacher community with those of larger community -are teacher efforts consistent with state standards and district standards? -commensurate or contradictory to decisions on resource allocation?

The last component of sustainability is *synergy*, which refers to the combination of the institution and the larger environment to create efforts greater than the individual parts. For instance, one might ask whether the efforts of the teachers and professional development programs are aligned with the efforts of the school and district. It is these four aspects of sustainability that form the framework for my study.

Scale

One concept closely related to the idea of sustainability within education is that of scale. Coburn (2003) reconceptualized the construct of *scale* from meaning solely the expansion of the number of schools involved in a reform effort (called spread) to include thinking about scale in terms of: depth, sustainability and a shift in reform ownership. Her main reason for doing so was due to the fact that many educational research articles frame arguments using the idea of 'scale' in a one-dimensional way to mean increasing the number of teachers, schools or districts involved. Traditional notions of scale might involve replication of the reform in a number of schools, mutual adaptation of reforms by a number of schools, or simply defining scale as increasing the number of schools involved. This quantitative focus does not capture the complex nature of thinking about what makes a reform effort grow - for instance, sustaining changes in a system that has many priorities as well as shifting priorities. "By focusing on numbers alone, traditional definitions of scale often neglect these and other qualitative measures that may be fundamental to the ability of schools to engage with a reform effort in ways that make a difference for teaching and learning" (Coburn, 2003, p. 4).

Reconceptualizing scale involves looking at depth, sustainability and shift in

reform ownership in addition to spread. *Depth* refers to the nature and quality of the reform implementation, effecting "deep and consequential change in classroom practice"(Coburn, 2003, p. 4). Depth is change that goes beyond surface features and/or procedures like changes in materials, or adding a particular activity to alter teacher beliefs, norms of social interaction, and pedagogical principles used in the curriculum. Teacher beliefs refers to those underlying assumptions on how students learn, the nature of mathematics, student expectations and what effective instruction means. Norms of social interactions refers to teacher and student roles in the classroom, patterns of teacher and student conversations, and the ways teachers and students treat each another. Pedagogical principles refers to changes in the underlying ways that students and teachers engage with materials and activities.

The next component of scale is sustainability. *Sustainability* refers to changes from the reform enduring over time." Schools that successfully implement reforms find it difficult to sustain them in the face of competing priorities, changing demands, and teacher and administrator turnover"(p. 5). *Spread* refers to the movement of the reform ideas to other sites. This is traditionally how scale was conceptualized. Lastly, *shift* in ownership refers to the movement of knowledge and authority of reform ideas from the external organization to the teachers, schools and districts. Depth, sustainability, spread and shift. Integration, linkage, organizational integrity and synergy.

A number of researchers are studying scale-up efforts for the field of mathematics education (e.g. Cobb & Jackson, 2011; Larsen et al., 2014). To support conventional teaching, one may allocate time and materials to direct and constrain

teachers. But to support teaching for understanding requires allocation of time for professional development, autonomy to teach with respect to content and methods of teaching that content, and allocating resources in response to teacher efforts.

By contrast, supporting teaching for understanding calls on administrators to enhance schools' capacity for change by allocating substantial time for professional development, by offering autonomy to teach in the content as well as methods of instruction, and most important, by allocating resources in response to teachers' efforts instead of limiting their efforts through resource or structural constraints (Gamoran, 2003, p. 66)

Literature Review

Lesson Study

As previously mentioned in Chapter 1, lesson study is form of teacher professional development popular across parts of Asia, including Japan, China, Malaysia, Singapore, Thailand, and Indonesia. It is a teacher-directed and collaborative vehicle¹ for teacher learning that focuses on understanding student thinking and content that occurs through a collaborative inquiry on designing, teaching, debriefing, and modifying research lessons. Murata (2011) posited five characteristics that are key to lesson study: that lesson study is teacher-led around teacher interests, student-focused, research lesson-focused, and is both a reflective and collaborative process. As Chokski & Fernandez (2004) described,

Like a map, lesson study is a tool for going somewhere. But the important questions to keep in mind are where we want to go, how

¹ Yoshida (2011) and Chokshi & Fernandez (2004) both referred to lesson study as a vehicle for teacher learning.

we want to get there, and what signposts we will use along the way (p. 524).

Murata (2011) reminds us about the importance of student thinking in the lesson study process. This focus of student thinking

helps cultivate a new attitude toward teaching, namely that teaching is not a one-way and didactic path, but a two-way integration of student ideas and content exploration meaningfully facilitated by teachers (p. 4).

Lesson study involves the collaborative practices of investigating, planning, teaching, and debriefing on a research lesson using ‘live’ teaching and observation (Fernandez & Yoshida, 2004; Lewis, Zwojewski, Chamberlin, Hjalmanson & Lewis, 2008). The *investigation* phase involves considering students’ thinking, and long-term goals about key concepts, studying standards, and reviewing textbooks and research. For example, teachers might decide after examining current standards on algebra that their long-term goal for students is to effectively argue and communicate mathematics. In the *planning* phase, members take what was learned in the investigation phase to develop or select a research lesson. Research lessons involve stating the lesson rationale and student learning goals, anticipating student thinking, targeting data collection, and connecting to a larger long-term goal. For example, a team might select a task about finding patterns on how many seats can fit around a row of triangle tables, and solve the algebraic thinking problem themselves.

Next the team members *teach* and *observe*, collecting data on the enactment of the research lesson. A team has one teacher teach the fourth grade lesson on patterns while other members and visiting university or experienced educators also observe the

lesson. Afterwards, the members meet for reflection where they *debrief* on observed data, discuss observations and resulting implications for revising the lesson, record what was learned about teaching, students' thinking, and the subject matter, and optionally revise and reteach the research lesson. A more knowledgeable other serving as an outside expert might comment on the lesson, providing insights that serve as human resources. An example of an idea that could result from this post-lesson reflection is evidence that the task was over-scaffolded. They may conclude that their structured worksheet "set it up for them, spoon fed them" and that the students might understand better without a worksheet and instead by "the messy business of organizing data" (Lewis, Perry, & Hurd, 2009, p. 293). Teachers optionally may choose to modify the research lesson and teach and debrief for a second time.

Chokshi and Fernandez (2004) recommended that, "The best way to learn about lesson study is simply to do it" (p. 524). They continued on to say that, "No matter how many structural supports, strategies, and experiences a lesson study group has prepared for, it can never anticipate the real issues it will face or the solutions that will evolve along the way" (pp. 524 – 525).

Research on Lesson Study

I now summarize research on mathematics lesson study to both situate my study and to demonstrate the appeal of lesson study – that its practice-based and collaborative nature helps to improve teachers' knowledge of mathematics, change their teaching practice, and develop professional communities.

In one of the first books on how U.S. schools could enact Japanese lesson study, Fernandez & Yoshida (2004) described the process of lesson study as a way to

improve mathematics teaching and learning. The book describes each of the stages of lesson study, what teachers talk about, and ways to respond to student thinking. The field has made great progress since Stigler and Hiebert (1999) wrote that “little has been written in English about the process of lesson study” in *The Teaching Gap* (p. 111). Lewis, Perry & Hurd, (2009) found three pathways where lesson study improved instruction – the areas of teacher beliefs and knowledge, professional community, and teaching-learning resources. They found three types of changes that occurred over a two-week period for a group of teachers: changes in teachers' knowledge (mathematical knowledge, student knowledge, and pedagogical knowledge), professional community (e.g. inquiry stance, ownership of improvement, shared long-term goals), and teacher-learning resources (improved lesson plans). The article served as an important existence proof that lesson study outside of Japan, particularly in North America, could be effective in changing instructional practice for the better.

We can group research on lesson study into four broad areas: (a) research that seeks to document the process of enacting lesson study within different school sites, referred to as the descriptive knowledge base, (b) research that seeks to understand knowledge for teaching mathematics, (c) research that seeks to understand changes in teacher practice, and (d) research that seeks to understand the development of professional learning communities. I briefly characterize each of these four research areas and describe relevant research situated within the research. I restrict my literature search to research on lesson study with practicing teachers, though I acknowledge that lesson study has also been used with pre-service teachers at the undergraduate level.

Descriptive Knowledge Base.

The first area of research found within the lesson study literature for mathematics education, the descriptive knowledge base, includes research that documents the process of lesson study, giving descriptive accounts of particular lesson study endeavors. Many articles add to the descriptive knowledge base, describing the setting and history associated with the professional development experience as each district varies. This could be due in part to the fact that lesson study is relatively new in the United States, and in part because lesson study engagement may vary site-to-site as it is not a nation-wide practice.

Lewis, Perry, Hurd, & O'Connell (2006) provided an important 'existence proof' that lesson study could improve instruction. The authors describe the growth, success, and conditions for efforts to implement lesson study in Highlands Elementary School that sought a different form of professional development at the end of the 1990s. The principal was eager to find a sustainable and teacher-led form of professional development to improve instruction at her school. Within the first year of lesson study, 26 teachers volunteered to conduct lesson study; within two years nearly all faculty joined; and within three years everyone joined. Teachers here conducted two cycles of lesson study each year and regularly shared what they learn to all faculty. Supported by the principal with two hours each month, lesson study replaced observations used to evaluate tenured faculty. It also served as a mentoring vehicle since both new and experienced teachers collaborated together. It finally was used as a way to make sense of new ideas, standards or curricula. This article was one of the first thick descriptions of a successful lesson study endeavor in the U.S.

In their article, Lewis, Perry, Hurd, & O'Connell (2006) describe four changes that occurred that highlight how the school's educators conducted effective lesson study to increase teachers' opportunities to learn. First, lesson study was about teacher learning and not solely lesson perfecting. Teachers quickly described lesson study as more than creating and sharing polished lessons; they described it as opportunities to learn, to test ideas out about how students think, and to deepen understanding about content. Second, attentive observation and engaged discussion of the lesson were necessary for effective lesson study. Educators noticed the observations and discussions by teachers shifted from surface level features like student behavior to more complex features like student thinking and data collection with these teachers who engaged in lesson study over a period of time.

Third, including outside sources of knowledge made lesson study better. The first year of Highland lesson study involved no outside sources of knowledge, compared to the sixth year where lesson study teachers asked educators to come often. Fourth, integrating and balancing phases of lesson study into non-research teaching could enhance lesson study. Initially, teachers did not often consider implications of the current research lesson on future teaching. Over time, teachers planned by reviewing student data and thinking about issues that arose with student thinking in prior work. Teachers often tested a lesson study idea in their classroom, and brought back data useful for planning the research lesson.

Fernandez (2009) reports on the work of one elementary lesson study group to examine educative benefits of lesson study for the enactment of reform teaching. Due to the fact that challenges of enacting reform-minded teaching and teaching that

encourages children to share and make meaning of each other's ideas means teachers will likely experience challenges during instruction, Fernandez argued that a way of developing teachers' ability to think on their feet about students' mathematical ideas, or knowledge for teaching mathematics, is needed. A variety of professional development efforts focused on engaging teachers in experiences attempt to help teachers learn how to teach mathematics, including co-teaching with a professional developer and/or colleague, examining artifacts from instruction, discussing videotapes, studying teaching cases, and participating in lesson study. The results of the study claim that lesson study contributed to providing opportunities for teachers to learn in two ways, and will be discussed under 'knowledge for teaching mathematics'. This article adds to the descriptive knowledge base due to the explication of one lesson study effort and the positive effects it had on improving teachers' knowledge for teaching mathematics.

In summary, a body of lesson study research documents some teachers' experiences with trying lesson study as a form of professional development.

Changes in Knowledge for Teaching Mathematics.

The second area of research seeks to understand whether knowledge for teaching mathematics develops from participating in lesson study. As discussed earlier, Fernandez (2009) found two ways that lesson study allows teachers opportunities to learn. After marking exchanges where teachers discussed mathematics covered in a lesson and how to best teach it, Fernandez found two ways in which lesson study offered teachers opportunities to learn. First, teachers had opportunities to develop pedagogical content knowledge. For example, teachers discussed ways

students would think about the context of sharing licorice equally, challenges of ways students would think about fractions and ways to teach fractions, and how to address said challenges. Second, teachers had opportunities to come to understand how to reason mathematically while teaching a lesson. Teachers had the chance to think about how to handle challenges that arise while teaching mathematics after teaching the lesson once and debriefing about it. The author describes one example where the first lesson used pretzel rods as a setting for fractions, which allowed students to measure the rods and give an answer in inches and not a fractional quantity. Consequently, the teacher of the lesson discussed how in the revised lesson she asked students, “[h]ow can you show what part of that pretzel you will all get no matter how long that pretzel is?”(p. 276). Discussing these issues allows teachers to develop a range of strategies to deal with similar situations that might arise in everyday lessons. Fernandez acknowledges that the opportunities to develop pedagogical content knowledge does not imply they developed the knowledge; teachers at least became aware of mathematical concepts that would need further work. Lesson study provides motivation and a method for teachers to do just that.

Meyer & Wilkerson (2011) analyzed twenty-four middle school mathematics teachers working in five lesson study groups for factors that supported teachers increasing their knowledge for teaching mathematics using lesson study as a form of professional development. Three factors that allowed for windows of opportunity to develop teacher knowledge about teaching mathematics included: (a) whether teachers took an existing lesson with few or no changes versus creating their own or making major changes to a lesson plan, (b) the presence of discussion about content and not

solely the implementation of the lesson, and (c) the level of anticipating students' questions/responses in lesson plans. Teachers in groups that made substantial changes to an existing lesson plan or created a new lesson plan (groups 2, 3 and 4) increased their knowledge for teaching mathematics. These groups also discussed understandings of mathematics, like of ratios and proportions, which supported windows of opportunity for growth in mathematical knowledge. Teachers in the other two groups (groups 1 and 5) used an existing lesson plan with little modifications, and focused on the implementation rather than the content of the lesson. These groups did not show evidence of increasing knowledge for teaching mathematics and instead focused on aspects like materials needed, roles of students, and who would teach the lesson during planning sessions. The fifth group's lesson plan was created by the assistant principal with limited input from teachers, taught by a teacher who did not follow the research lesson, and had only two members of the team who attended the six-hour professional development on lesson study.

Additionally, groups that increased their knowledge for teaching had spent much time discussing and anticipating student questions and responses. Many of these anticipated responses were predicted correctly; for example, teachers predicted students would say, "how do we figure this out?" or, "how am I supposed to figure this out without a ruler?" when measuring an object without a ruler (p. 22). Teachers from groups 1 and 5 did not spend significant amounts of time discussing and anticipating student questions and responses.

Lewis, Perry & Hurd (2009) described how lesson study contributed to changes in teachers' knowledge and teacher beliefs. The change in teachers' beliefs

and knowledge on understanding the geometrical reason for the seat pattern $n + 2$ resulted from the feature of lesson study of observing students counting and then making their observations visible during group reflection. Having student thinking comprise a large component of the lesson study process (e.g. in the investigation and planning components) allowed teachers to focus their attention on student reasoning and subsequently revise their lesson, like having students share their methods of counting in front of the class. Consequently, the authors suggested that the student thinking feature of lesson study appeared to lead to a change in teachers' knowledge and beliefs.

Other studies about changes in teachers' knowledge for teaching described an increase in awareness of certain aspects of teaching mathematics. Robinson and Leikin (2012) described a study in which they analyzed participation of one teacher to determine mechanisms by which teachers learn. Analyzed on two levels – macro-level analysis as well as micro-level analysis – the authors concluded that collaborative noticing, collaborative awareness, and brainstorming were the mechanisms of teacher change in a round of lesson study. Alston, Pedrick, Morris & Basu (2011) describe a study in which teachers' awareness of students' mathematical thinking was developed as a result of participating in lesson study. Knapp, Bomer & Moore (2011) describe a study in which mathematics coaches and teachers developed knowledge for teaching. Together, these articles inform the field on ways that lesson study can affect changes in teachers' knowledge for teaching.

Changes in Teacher Practice.

Murata, Bofferding, Pothén, Taylor & Wischnia (2012) analyzed how teachers

made sense of three instructional dimensions – student learning, teachers, and content – with respect to representations like number lines and how talk and practice changed over the course of eight meetings (6 months) during the second year of a two-year lesson study endeavor for elementary teachers of mathematics. They found two results: (a) changes in both individual and group talk, with an overall pattern of teacher talk moving from lower to higher levels, (b) learning in particular contexts, and highlighted the growth of one teacher named Andrea during the lesson study process. For changes in group talk, the pattern of group talk went from discussing student learning, to content, to teaching, then back to student learning of mathematics. The authors conclude that as a result of this pattern, it can be understood that professional development can lead teachers down certain paths of discussion to connect different aspects of the profession together (e.g. the three dimensions of student learning, teachers and content).

Individual teacher talk moved from lower to higher levels of talk. That is, teacher talk moved from no evidence-based claims to evidence-based claims with connections among topics. Individual topics of interest or topics perceived as relevant for the three teachers. For each teacher, the amount of time spent in a particular dimension corresponds to a particular dimension and how to connect two dimensions. Sometimes the teachers' talk focused on the same dimension, which resulted in teachers building off of each other's ideas, and other times talk varied across dimensions, which added variety and richness to the teacher talk.

Olson, White & Sparrow (2011) examined ways that teachers integrated insights and aspects of lesson study that promoted reflection, collaboration and change

into their practice by studying two successful and one unsuccessful lesson study groups. Three teams began professional development using lesson study, yet one team abandoned lesson study due to time, especially time away from preparing their fourth grade students for a state test, and difficulty of managing along with three sets of teaching materials. Authors found pedagogical changes as exhibited within teachers of the two successful lesson study teams: there was a shift from focusing on teaching methods, delivery of content, cosmetic changes of task, generic reflections, and a teacher-preferred strategy towards asking more purposeful questions and used student contributions to make instructional decisions. In other words, teachers asked questions to figure out the mathematical ideas students were using. In contrast, the teacher that did not continue with lesson study continued a traditional initiate-respond-evaluate type of discourse, showed students procedures, and asked questions that led to expected student responses.

Hart & Carriere (2011) examined whether eight third grade teachers participating in lesson study developed three critical lenses or habits of mind – research, student and curriculum developer lenses – needed for a productive lesson study community. Analysis of data suggest that teachers developed a richer student and curriculum habit of mind but not a research habit of mind. Teacher comments about students in the first round centered on what students did (e.g. they listened, girls shared more than boys) and on how they behaved (e.g. students were calm or played with name tags), whereas comments in the fourth round centered on what students seemed to understand about the mathematics and what was confusing (e.g. I'm not sure students really know what a denominator is yet). Teacher comments about

curriculum development also changed over the course of the year, moving from how the organization of the lesson helped with management issues of students (e.g. Not sure about manipulatives since they played with them) to how the organization of the lesson facilitated or impeded student understanding (e.g. wondering about how students understood the shading). There was no evidence of the researcher lens in the first session, and some evidence in the last, though not a rich one.

Inoue (2009) investigated how teachers use the *neriage*, or consensus building classroom discussions, stage of inquiry using a video-based lesson study with six U.S. teachers, 3 Japanese teachers, and a facilitator/researcher. A powerful conclusion that the teacher participants came to conclude during the study was teachers' consensus about allowing students the chance to think deeply to solve problems rather than listen to the teacher's evaluation of the problem about the nature of *neriage*:

The group also agreed that the main purpose of consensus building is to give students the opportunity to think deeply about different ways to approach the problem and then construct an integrated idea, rather than just listening to their teacher evaluate which strategy is right or wrong (Inoue, 2009, p. 11).

Another area in which lesson study has been shown to be useful for learning new pedagogies is for understanding how teachers could learn to teach mathematics aligned to the reform movements (Fernandez, 2009; Lee & Ling, 2013; Lewis & Perry, 2014; Lewis & Takahashi, 2013; Takahashi, Lewis & Perry, 2013). For example, Lewis & Perry (2014) described how providing teachers with lesson study kits with instructional resources for mathematics, like how to teach with a linear

measurement representation of fractions, could support teachers with the implementation of fraction standards.

Development of Communities of Practice.

The last theme of lesson study research is the use of lesson study to develop professional communities. Lesson study is one way to establish and develop professional learning communities (Yoshida, 2012).

I believe that in order to improve student learning in regular classrooms, the majority of teachers in the USA need to be focussed on lesson study that help to developing their content, pedagogical content, and curriculum knowledge by developing PLCs [professional learning communities] where they can help each other improve throughout their careers (Yoshida, 2012, p. 141).

By building a community with particular ways of creating, testing and revising research lessons, those ways and norms of participating as a teacher of mathematics might remain even with teachers moving in and out of schools.

Lewis, Perry & Hurd (2009) describe one feature of lesson study that supported changes in the professional community to be lesson reflection and revision. In their study, groups reflecting on the lesson together and thinking about changes to make for their next lesson helped to create a stance towards inquiry by the teachers and change the professional community. The authors caution that teachers' beliefs about professional development could have also contributed to the three changes reported in the paper. As suggested by a pre-service teacher participating in a lesson study research experience as part of their middle school mathematics methods course,

Another important thing to note is that lesson study by itself does not improve teaching. If the group of teachers does not put the time and effort into it, or do not have the knowledge or don't research their topic, the study is ineffective (Burroughs & Luebeck, 2010, p. 398).

Lieberman (2009) analyzed one case of a high school mathematics department using lesson study as a vehicle for developing teacher learning communities to examine whether lesson study participation can develop a learning community that supports teacher identities about student and teacher learning. The author documents changes in and how to break the following norms: *individualism* (isolated teaching environment), *conservatism* (teaching as a teacher was taught), and *presentism* (practicing to meet short-term goals for immediate reward). She concludes that it is possible for teachers to learn even with the existence of these norms through engagement with lesson study. The teacher norms that encourage the above norms include characteristics like openness, collaboration and critical design of curricula. This existence proof of the ability for lesson study to provide a structure on which to build up a community that, over the course of seven years, allowed for the development of teacher professional identities.

Finally, Murata & Takahashi (2002) found that lesson study gave 126 surveyed Japanese teachers a space to connect theory to practice and also provided the opportunity for teachers, researchers, and administrators to communicate among one another.

Research on Factors that Support and Hinder Lesson Study

There is some research on lesson study that examines factors that support and

hinder the implementation and continuation of lesson study with respect to teachers and administrators (Chokski & Fernandez, 2004; Fernandez, 2005; Stepanek et. al, 2007). Chokski & Fernandez (2004) identified challenges related to implementing, practicing, and sustaining lesson study. Challenges for implementing and “importing” lesson study in the U.S. context included (a) lesson study cannot occur in the U.S. since it originated in Japan, (b) U.S. teachers do not have time for lesson study, (c) lesson study needs to show proof that it improves student learning so that teachers can justify its use, (d) U.S. teachers do not have sufficient content knowledge for lesson study, (e) U.S. teachers are too “self-conscious” to deprivatize their practice and open their classroom to other teachers, and (f) teachers cannot do lesson study since each has a unique teaching style. Chokshi and Fernandez responded to each of these challenges for implementing lesson study and argued that in spite of these, lesson study could still be used by U.S. teachers as a vehicle for teacher learning.

When addressing misconceptions related to practicing lesson study with teachers new to lesson study often hold about the purpose of lesson study, Chokshi and Fernandez (2004) described the following: (a) lesson study is for creating original lessons, (b) it is not useful to conduct a few lesson studies, but rather one must conduct a large amount of lesson studies, (c) lesson study is for creating perfect lessons, and finally, (d) lesson study is about creating a repertoire of tested lessons so that others may use them. The authors concluded that instead, lesson study “is more about engaging in the intellectual process that fuels its activities than it is about the isolated products of these activities”(p. 523). When addressing nuanced pitfalls related to sustaining lesson study, they described the following: (a) the research focus is

automatic for teachers, (b) teachers must adopt Japanese teaching practices to do lesson study, and (c) that lesson study necessarily leads to productive conversations about teacher practice. They argued that the research focus must be addressed at each step of planning student activities, teachers do not have to adopt Japanese teaching practices to engage in lesson study, and only if teachers can negotiate the balance of politeness and critical honesty will lesson study lead to productive conversations about teacher practice. The authors stated that lesson study was not a process for mimicking other practices, but for teachers to change practice from reflecting on real experiences of testing different ideas. The following quote summarized these sentiments.

But the central idea of lesson study is that it is meant to be a *generative* process through which teachers continually improve and redirect their teaching as needs arise from their students and classrooms. Lesson study is therefore not meant to be a vehicle for teachers to assume an entire set of static teaching practices. On the contrary, it is intended to encourage teachers to adopt practices based on dynamic experience and deep reflection (p. 524).

The authors concluded with suggestions for planning a productive lesson study journey: (a) teachers should shift from meeting about lesson study to engaging in lesson study, (b) teachers should create a network of different lesson study groups so that they are “worth more than the sum of its parts” through these connections (p. 525), and (c) teachers should make use of more knowledgeable others such as outside experts to maintain critical insights.

In a chapter of an overview of lesson study, Murata (2011) highlighted four challenges to implementing and adapting lesson study: (a) the cost of implementing lesson study, for teachers to plan and teach the research lesson during school hours,

and to debrief with an outside expert, (b) sustaining lesson study over long periods of time rather than experience a professional development experience as many U.S. teachers do, which is “as discrete and separate programs form one year to another,” (p. 9) (c) insufficient teacher content knowledge to assist in teachers’ future learning with lesson study, and (d) the connection between teachers’ participation in lesson study’s and student learning to suggest the effectiveness of a professional development effort. She argued that by addressing these complexities of lesson study through documenting how people and institutions address these issues, weaknesses and strengths of our educational systems would be exposed.

One of the largest studies yet on lesson study implementation in the U.S. was by Akiba & Wilkinson (2014). They examined state and district approaches in the state of Florida, which was the first state to promote lesson study broadly, to understand sense-making processes of policymakers and administrators when establishing conditions to promote lesson study implementation. They found that existing structures surrounding professional development served as a challenge for district leaders and teachers to implement lesson study. They also found that although funding was available due to Florida’s participation in a grant, a majority of school districts mandated lesson study without securing or spending appropriate funds. Akiba & Wilkinson described some of the following issues while promoting lesson study: (a) teachers’ schedules not allowing teachers to engage in continuous lesson study; (b) a lack of understanding of the lesson study process’s nature of designing lessons, gathering data, and making particular conclusions based on the data and general implications for the improvement of teacher practice and student learning; and finally,

(c) a lack of resources and opportunities to develop content and pedagogical content knowledge needed to engage in lesson study by themselves.

The characteristics of lesson study as an institutionalized process that is embedded into the organizational structures and routines that support teacher leadership and ownership of professional learning process, continuous research-based professional learning process, and profession-wide networks and knowledge building were lost in the sense-making processes of the state and district leaders in developing a lesson study policy (p. 38).

The same authors reported ways that districts thought they would continue to engage in lesson study after their state funding ended (Akiba et. al, 2015). Thirty-four of the approximately fifty school districts surveyed indicated that they had a plan to sustain lesson study after the current school year, with district representatives explaining methods of sustaining lesson study to include (a) continuing training for teachers, school administrators, and district staff and facilitators about lesson study, (b) continuing to fund lesson study support or seek other funding, and (c) continuing to use common planning time for lesson study.

As with any new movement, caution must be paid when learning about the new phenomena to ensure integrity. Yoshida (2012) described five issues that act as barriers to conducting lesson study within the U.S. to include: (a) a misunderstanding or lack of understanding of lesson study, (b) not enough content and pedagogical knowledge within teachers, (c) insufficient resources and support for conducting high caliber lesson study, (d) a non-systematic approach to conducting effective lesson study, and (e) a lack of a long-term plan for improving PD and time for PD. For lesson study to be effective and high-quality, addressing these issues will help teachers learn

mathematics content knowledge, pedagogical knowledge, and curricular knowledge using lesson study as a vehicle of professional development.

In summary, there is increasing evidence of research on factors that support and hinder the implementation, practice, and continuation of lesson study. Murata (2011) calls for the need to understand how aspects of lesson study could be modified while maintaining its key features to better understand educational systems as they are and the cultural values and beliefs supporting it. Documenting changes to an existing system will help educators understand how the system works and seek out critical components of that system.

Summary of Research on Lesson Study

Lesson study has only recently been used in the United States since the 1990s. Recent research on lesson study used with practicing mathematics teachers can be characterized into four areas: (a) research that seeks to document the process of enacting lesson study within different school sites, called descriptive knowledge base, (b) research that seeks to understand knowledge for teaching mathematics, (c) research that seeks to understand changes in teacher practice, and (d) research that seeks to understand the development of professional learning communities. Though much evidence exists on the use of using lesson study to improve student and teacher learning (e.g. Fernandez, 2005), little research exists on implementing lesson study and less on sustaining and continuing it.

Researchers within mathematics education call for future directions in lesson study (Fernandez, 2005; Lewis, Perry, & Murata, 2006; Murata & Takahashi, 2002). Lewis, Perry & Murata (2006) detail six implications for research on lesson study for

improving instruction. These include (a) to recognize 'local proof' as a meaningful route to educational improvement, (b) to recognize trade-offs between 'local' and 'general' proof, (c) to ask if summative research is reasonable and ethical, (d) to define lesson study productively, (e) to encourage refinement, and (f) to learn across boundaries. Fernandez (2005) calls for “more systematic examination of this practice” and not just speculation (p. 285). “Continuing in this direction represents a long road ahead but it is one that is important for us to travel if lesson study is to be thought of in an informed way” (pp. 285-286). Murata & Takahashi (2002) call for studies that examine teaching learning and change as a result in participating in lesson study, as well as student learning in the lesson study classrooms.

Fernandez (2005) suggests three paths for lesson study research, coming to understand: a) what teachers can learn from engaging in lesson study (e.g. orchestrating discussion or developing language for talking about teaching), b) how lesson study opportunities to learn compare to opportunities to learn within other professional development that centers on examining teacher practice, and c) how knowledgeable others can support lesson study groups so that researchers may untangle the source for what teachers get out of lesson study (e.g. intrinsic value or those who support the work). My work contributes to what Lewis, Perry & Murata (2006) refer to as the descriptive knowledge base and potential mechanisms by which teachers, districts, and universities can sustain lesson study professional development.

Lesson Study and Sustainability

A number of educational studies focus on studying educational systems to sustain reform (Fullan, 2005). Few studies about lesson study focus on designing and

supporting lesson study for sustainability (e.g. Akiba, in press; Gero, 2015; Lewis, Perry, Hurd, & O'Connell, 2006; Lewis & Perry, 2014). In addition to describing the growth and success in implementing lesson study in an elementary school, Lewis, Perry, Hurd, & O'Connell (2006) documented the productive changes that allowed the school to transform their form of professional development into a school-wide lesson study where all teachers participated within three years. Lewis and her colleagues detail four conditions that would be required to scale up successful lesson study based off of their experience of successful lesson study implementation and continuation. These conditions included (a) involving multiple sites with lesson study to build on what others have learned, (b) having a diverse range of resources, including curricular resources, groups, and other educators, for teachers to use to support lesson study, (c) linking lesson study as a way to scrutinize difficult topics or portions of curriculum to the improvement of textbooks, and (d) providing demand for an 'inside-out' reform from educators. Together, these conditions were found to be necessary for a lesson study effort to be successfully scaled-up.

Lewis & Perry (2014) studied how 39 lesson study groups engaged in a cycle of lesson study with mathematical resources and changed their understanding about the topic of linear measurement of fraction representations of fractions. The design of the study included mailing locally arranged groups recruited through both personal and internet networks mathematical and lesson study resources, with instructions to help the groups engage in one cycle of lesson study with no other support to local educators by the researchers. The experimental groups received materials on fraction representations as linear measurements, while the control groups selected their own

topic. The two researchers coded pre- and post-assessments on teachers' understandings of fractions measured through questions from the LMT instrument and other published research assessments and coded by two researchers; written reflections from an end of the lesson study cycle prompt about things learned from the cycle; and lesson study video and artifacts. Significant increases in three of four area of fraction knowledge occurred in the experimental lesson study groups, with both experimental and control group teachers showing significant decreases in errors on fractions. Lewis and Perry concluded about scaling up that "the intrinsic rewards of learning about content and student thinking ... bode well for sustainability of this form of professional learning" (p. 36).

Resources are necessary but not sufficient in supporting teachers to continue to engage in lesson study. Gamoran and colleagues (2003) assert the need to go beyond distributing resources, including material, human and social resources as a way to control teachers towards building and supporting institutions that give resources in response to teacher initiatives. "Teacher professional development is a driving force for change, because it alters the nature and distribution of resources in a district and its schools" (p. 174).

Summary of Literature Review

The proposed study seeks to understand the factors that support and hinder four lesson study groups that continue to sustain after the grant has ended. These experiences are viewed from a situated perspective. From this perspective, the nature of how communities of teachers participate deeply shape how they think about

teaching mathematics. Lesson study, by its very nature, occurs from teachers participating in the activity of the creation of and reflection on a research lesson.

The literature review on lesson study can be categorized into four groups: descriptive knowledge base, changes in knowledge for teaching mathematics, changes in teacher practice, and development of professional communities of practice.

Research shows that lesson study can be used successfully to develop knowledge for teaching mathematics, change teacher practice, and develop professional communities of practice.

A review of the lesson study research shows a relatively small number of studies that make explicit their theoretical grounding as rooted in sociocultural ideas (cf. Lewis, Perry, & Hurd, 2009). Consequently, my work will contribute to bridging the use of explicit theory that guides the design and analyses of mathematics teachers' practice to better understand issues related to sustainability of lesson study. Lewis, Perry & Murata (2006) call for research in the following three areas: (a) expanding the descriptive knowledge base of both Japanese and US lesson study, (b) explaining mechanisms of lesson study that result in instructional improvement, and (c) testing out design-based research.

Understanding why some lesson study groups sustain and others do not is an area of research that combines research on lesson study with research on professional communities of practice. There have been some successful attempts at sustaining long-term lesson study groups (e.g. Lewis, Hurd & Perry, 2006). Yet more research is needed to unpack the complexities of continuing lesson study as a form of professional development. What conditions would foster the maintenance of teacher practices

around lesson study? Of particular interest for is the current study, which has a number of supports set in place for mathematics teachers to continue to use lesson study in their districts.

Chapter 3: Methods

In this chapter, I explain the overall design of the study. I discuss the data collection and analytic methods, and their relevance to pertinent research questions. I conclude this chapter by addressing issues of validity and reliability.

Introduction

The aim of this study is to better understand factors that support and hinder teachers' ability to continue to engage in lesson study after external funding ends. To do so, I utilized research methods to examine mathematics teachers' activities as they were situated within institutional settings of schools and districts (Cobb, McClain, Lamberg & Dean, 2003). An important aspect of understanding the institutional setting included understanding the perspective of those involved in lesson study, namely the teachers. Hargraves (1994) echoes this when he noted about teachers' work that "teachers' voices have either been curiously absent, or been used as mere echoes for preferred and presumed theories of educational researchers"(p. 4). It is important to seek to use teachers' words not only exemplify theories, but to perturb and push these theories in interesting ways.

The analytic method for this study combined analyses of survey, interview, and social network data. This allowed me to attend to "teachers' interpretations and understandings while simultaneously treating those interpretations and understandings as situated in and at least partially constituted by the institutional settings in which they work" (Cobb, McClain, Lamberg, & Dean, 2003, p. 13). In what follows, I give details of the setting, participants, research questions, and data corpus before describing data collection and analyses.

Overview of Research Design

In the sections that follow, I elaborate on the design of the study.

Setting

The setting for this study occurred in 2013 – 2014 during the first school year following the completion of a three-year partnership grant funded by a California Mathematics and Science Partnership grant called Project X. During Project X, mathematics education faculty at a large university in the southwestern U.S. worked with district administrators and mathematics coaches, who were also full-time teachers, to provide professional development in the area of algebraic thinking for teachers of grades 3 – Algebra I (students aged 8 to 16) for approximately 80 teachers across two school districts, Long Pond and Sun Valley. Project X provided a week-long intensive workshop each summer on themes of deeper understanding of algebraic concepts, students' algebraic thinking, and pedagogy for teaching algebraic thinking, with several cycles of lesson study during each of the three academic school years, two cycles where teachers co-planned, teach and observed, and debriefed, and two cycles where teachers observed and debriefed on another team's research lesson. For the rest of this document, I refer to this three-year partnership grant as *Project X*.

Participants

Teachers, principals, and Teachers on Special Assignment (TOSAs) from both districts participated in this study. All approximately 80 teachers who engaged in the Project X grant were invited to participate in the current study along with principals of some participants. Some of the participants were TOSAs hired by the district, who previously worked as a teacher but currently served as a coach for the current school

year. An invitation was sent electronically to invite all participants to participate in an online survey after the grant ended, with a further invitation to participate in a follow-up interview. Participants received compensation in the form of a gift card for their time spent taking a survey and/or participating in an interview.

Twenty-six teachers (12 from Long Pond and 14 from Sun Valley) participated in online surveys, or approximately 32% of Project X teachers, and thirty teachers (16 from Long Pond and 14 from Sun Valley) participated in interviews, or approximately 37% of Project X teachers. Eighteen teachers engaged in both survey and interviews (nine from each district), or approximately 22% of Project X teachers.

Teachers spanned grades three through high school mathematics. For surveys, there were ten elementary school teachers, fourteen middle school teachers with three of these fourteen being resource specialist teachers, and two high school mathematics teachers in the subjects of algebra and geometry. For teacher interviews, there were seventeen elementary teachers, twelve middle school teachers with three of these twelve being the same surveyed RSP teachers, and one high school algebra teacher. Three TOSA mathematics coaches participated in this study, with each TOSA involved as either a mathematics coach or co-investigator of Project X. Principals who were reported in preliminary interviews with TOSAs to support teacher collaborations like lesson study were invited to participate in this study. In total, five principals participated in this study. Although these principals did not directly engage in the Project X grant like the teachers², these principals worked at sites where Project X

² Each principal interviewed worked as a principal at a site with Project X teachers.

teachers worked. See Table 3-1 for a list of study participants indicating their district, gender, position, and the types of data collected for each.

Table 3-1. List of participants and corresponding data.

Participant	District	Gender	Position	Position during PA	Completed Survey	Completed Interview
Bertha	Long Pond	F	4	teacher		x
Carmen	Long Pond	F	4	math coach and teacher		x
Jimmy	Long Pond	M	5	teacher		x
Ben	Long Pond	M	5	math coach and teacher	x	x
Mia	Long Pond	F	5	teacher		x
Principal Ron	Long Pond	M	principal	principal		x
Anita	Sun Valley	F	8	teacher	x	x
Kamille	Sun Valley	F	7	teacher	x	x
Nancy	Sun Valley	F	6	teacher		x
Principal Kate	Sun Valley	F	principal	principal		x
Tonya	Long Pond	F	7	teacher	x	x
Don	Sun Valley	F	5	teacher	x	x
Kerry	Sun Valley	F	5	teacher		x
Ceci	Sun Valley	F	3	teacher	x	x
Principal Paula	Sun Valley	F	principal	principal		x
Dianna	Sun Valley	F	TOSA	math coach and teacher		x
Kimmy	Long Pond	F	TOSA	co-investigator		x

The location for this study occurred at the respective schools and district administration buildings of those teachers involved in Long Pond and Sun Valley³

³ Gender-preserving pseudonyms used throughout the study.

school districts. The participants met either one or two researchers in a classroom, workroom reserved for teachers, or an office at the district office. One interview occurred at a restaurant to accommodate the participant. Most interviews occurred after school, though some took place during a participant's preparation period during their workday.

All participants were familiar with the lesson study process since they engaged in lesson study training and cycles during Project X for three years. Additionally, participants in both Long Pond and Sun Valley school districts had access to a TOSA or mathematics coach who was familiar with the lesson study process.

Research Questions

Before discussing the data corpus, data collection, and analysis methods, I restate my research questions:

1. What practices of lesson study continued after the grant ended?
2. What are teachers' conceptions of lesson study?
3. What factors supported and constrained teachers' ability to continue lesson study?

This study consisted of several phases of analysis: resources analysis, sustainability analysis, practices analysis, and conceptions of lesson study analysis. I analyzed reported resources using Gamoran's (2003) characterization of resources, including material, human, and social resources. I analyzed sustainability using a modified version of Gamoran and colleagues' (2003) framework for sustainability involving linkage, integration, and synergy. Interviews with the former co-principal investigator of Project X informed the selection of interviews with teachers and

principals for grounded theory analyses that served to derive codes from the data. Social network analyses served to quantify linkage, one of the facets to the sustainability framework. The practice analysis involved analyzing teacher interviews for the presence of the components of lesson study using the definition of lesson study from the literature. The conceptions of lesson study analysis involved analyzing teacher interviews for themes in their reported descriptions and uses of lesson study. Multiple case study analyses was used to compare four cases to provide depth and contrast across each of the research questions.

This study fits within lesson study research within mathematics education by employing qualitative methods of grounded theory and case studies and some quantitative methods of social network analysis to analyze issues related to mathematics lesson study from a social perspective involving communities of teachers situated within complex institutional settings. It also extends lesson study research by contributing knowledge about sustaining and implementing lesson study with practicing teachers.

Data Corpus

A number of types of data were collected for the study:

- Online survey data
- Three types of interview data for teacher participants and administrators like principals and TOSAs
- Field notes data from researchers about the context of the school and nature of teacher meetings
- Educational objects data like analytic memos and emails between the

former co-investigator of the grant

Below, I describe each data source.

Online Survey Data.

The online survey instrument was adapted from Gamoran and colleagues' (2003) Likert-scale survey called *Survey Items used in the Analyses* (See Appendix 2). All former Project X teachers were invited to take this multiple choice, write-in, and short response online. The survey asked participants whether lesson study continued at their site, whether they completed a cycle of lesson study since the end of the grant, resources that supported and constrained lesson study, the school-wide vision for student learning at their site, support for innovative ideas and teaching from the principal and colleagues, and perceptions of professional development and gave space for additional comments. Out of the 26 surveys collected, there were four third-grade teachers, two fourth-grade, four fifth-grade, 12 middle school teachers (two sixth-grade, two seventh-grade, four eighth-grade, one 6/7, two 7/8, one 6/7/8), and two high school teachers of algebra and geometry. Of these 26 surveyed participants, 18 agreed to participate in a follow-up interview, nine from each district.

Sustainability Interview Data.

I collected individual, semi-structured interviews (Barriball & While, 1994; Fetterman, 2010) from teachers, principals, and TOSAs. In semi-structured interviews, conversations are guided by a set of predetermined and open-ended questions. Predetermined questions allow for a systematic analysis of responses while open-ended questions allow for flexibility for asking follow-up questions to probe deeper on

responses for a particular reason (to ask for clarification, to ask why he or she thought about a particular idea, among other reasons).

Barriball & While (1994) discussed five advantages to collecting semi-structured interviews (as opposed to unstructured interviews like the clinical interview, structured interviews like some think-alouds, or relying solely on survey data). First, semi-structured interviews often result in better response rates than other instruments, like surveys. Second, they are useful for exploring qualities like values and beliefs. Third, semi-structured interviews provide the opportunity to check the validity of a respondent's claims through attention to gestures (eye gaze, hand and arm gestures, and facial expressions). Fourth, they are also useful for comparing answers to questions through ensuring that respondents answer all questions. Fifth, semi-structured interviews ensure that respondents answer questions without the assistance from others, which could occur on a survey instrument. Additionally, Bertrand (2006) stated their usefulness in situations where the interviewer might not have the opportunity to follow-up with the respondent.

For teachers, I invited participants to engage in individual, semi-structured interviews using two methods. First, I asked participants via the survey if they would be interested in a follow-up interview to expand on their responses. Second, I used the snowballing technique for collecting participants discovered that appeared to play a role in teacher collaboration as discerned through interviews with other participants. The snowball technique involves interviewing those participants named by interviewees (Carolan, 2014; Cobb, McClain, Lamberg & Dean, 2003; Cobb, Zhao & Dean, 2009). As mentioned previously, 18 of the 26 surveyed participants agreed to

participate in an interview. Twelve other teachers who did not complete a survey participated in an interview.

I designed teacher interviews to elicit information about who teachers worked with, the nature of their collaborative activities, their work with lesson study, resources that support their work, resources that would support lesson study, uses of lesson study, and changes they would make if they were to do another cycle of lesson study. I also asked about the goals of the groups that teachers reported working with and the goals of the district. As is the nature of a semi-structured interview, follow-up questions about relevant topics arose during each interview, which allowed me to tailor the interview to individual teachers. Questions remained targeted to the nature of teaching mathematics and the nature of participating with other teachers, with an emphasis on planning, teaching, and debriefing mathematics lessons. (See Appendix 3).

For principal interviews, participants were selected based on two criteria. First, principals had to be working at sites with Project X teachers who participated in the current study. The purpose of prioritizing these principals was to learn more about potentially making use of the expertise of the former Project X teachers at their sites. It also served as one way to triangulate teacher interview data. It often was the case that principals were identified in teacher interviews. Using the snowball method implied following up with some principals, in addition to other teachers. Second, participating principals were identified by a TOSA as relevant to understanding lesson study efforts. TOSAs, who worked extensively with principals and teachers, had important insights about collaboration at different school sites.

I designed principal interviews to elicit information about teacher collaboration and support for it at their site. Specifically, I asked each principal about: the nature of teacher collaboration at their site, the role that they played in supporting their teachers, their goals for effective teaching, the nature of effective teaching, resources provided by both the district and the principal to support collaboration, how she/he viewed professional development for teachers at her/his site, how goals for teachers are communicated, what lesson study is useful for, resources that would support lesson study, and finally, how the implementation of the Common Core Standards has affected teacher collaboration if at all. See Appendix 4.

For TOSAs interviews, two participants representing each district were interviewed in the beginning and middle of the school year to give background and historical context for each school site, with another TOSA interviewed in the middle of the school year. All TOSAs previously taught middle school mathematics prior to their current position. One TOSA served as a co-investigator of Project X while the other two TOSAs were teachers who also served as mathematics coaches during the grant. During the time of the interview, the two teacher mathematics coaches became full-time coaches for middle and high school mathematics teachers, one in each district. The former co-investigator was a TOSA who served in an administration position. Each interview provided information on the nature of professional development in each district, in particular with lesson study. These interviews were not structured, with questions instead focused on eliciting information about both teachers' and the district's status with lesson study.

Field Note Data.

For case study participants, field note data were collected during their weekly collaborative meetings. These notes centered on the nature of interactions of the teacher participants, the content of discussions, and activities engaged in during 50-minute meetings.

There are a number of implications for writing ethnographic field notes. First, field notes are inseparable from the findings. Since the findings are a product of the method she might use, we can see that the findings rely heavily on the methods. At the same time, methods might rely heavily on what is noted from a field. The second implication of ethnography as inscription of participatory experience is that indigenous meanings must be given special attention. A researcher must get close to that which they would like to study to understand what their practices mean to them from their perspective. Field notes provide the researchers an account of experiences, meanings, and concerns, and not necessarily those direct experiences of those who are being studied. Third, field notes are an essential and necessary component of writing about others' lives and concerns. They provide the primary means by which the researcher makes their understandings of others' lives. Lastly, field notes must describe both social processes and processes of interactions of people in their activities. This means that a researcher must provide enough detail of others' lives so that they give an accurate portrayal of the social and interaction processes of people in their day-to-day activities.

For some participants, additional data like contact forms, analytic memos (Miles & Huberman, 1994) and email correspondence were collected. Writing an

contact form is a “rapid, practical way to do first-run data reduction without losing any of the basic information (the write-up) to which it refers,” and are meant to capture “thoughtful impressions and reflections” (p. 52). Verbal contact forms were recorded after each time interview data were collected to summarize interviews and highlight meaningful insights gained with respect to my guiding research questions. Another tool that helps document initial analyses are analytic memos, which “tie together different pieces of data into a recognizable cluster, often to show that those data are instances of a general concept” (Miles & Huberman, 1994, p. 72). They can be written for a variety of reasons, including reflections on surprises about a case, alternative hypotheses, suggestions for a new code, integration of remarks on field notes, clarification of ideas, or descriptions of themes or metaphors arising from observing data.

Preparation.

As mentioned under interviews, this study was informed by an end-of-the-grant paper survey and TOSA interviews that provided information about the status of mathematics teacher professional development in each district as well as. Dr. Nickerson, co-investigator and algebra teacher, Kimmy, and myself created an informal end-of-the-grant paper survey in May 2013 to better understand whether teachers wanted to continue with lesson study, when they would practice lesson study, and with whom would they collaborate. Approximately 75% of teachers expressed interest in continuing.

Additionally, interviews with TOSA and former Project X mathematics coach and current TOSA mathematics coach, Dianna, served to explain the institutional

context within their respective districts (Long Pond and Sun Valley) and give insight into mathematics teacher professional development and lesson study. This role is called a *broker*, which is defined as a person with memberships in at least two different communities (Cobb et. al, 2003). Specifically, they each gave insight into the activities engaged in by Project X teachers for the current year, the types of support given at each site by the district, and current professional development goals for teacher instruction. For instance, this district administrator helped coordinate a one-day lesson study effort at the beginning of the 2013-2014 school year and was able to report on teachers who volunteered for this experience. These TOSAs were familiar with the type of supports at each school since they each had a professional relationship with many principals in the district. These conversations with brokers played an important role for triangulating claims and seeking out principals at particular site.

Data Collection

In this section, I describe the collected data and the specific methods of its collection. I also relate each data source to the research question(s) that it addresses.

I gathered data in a number of ways. First, as mentioned previously, all former Project X teachers were invited to take an online survey. In the online survey, teachers were asked if they wanted to participate in a follow-up, in-person interview to expand their answers. Not every participant who completed the online survey participated in an interview. Eighteen of the 26 survey respondents agreed to an interview.

A second way that I gathered data included using the snowballing methodology to interview key teacher, principal, and district administrators about efforts to sustain the lesson study professional development communities (Carolan,

2014; Cobb, McClain, Lamberg & Dean, 2003; Cobb, Zhao & Dean, 2009; Spillane, 2000). In this methodology, I first interviewed participants and asked questions surrounding lesson study. I then interviewed those teachers, site administrators, and district administrators identified by the participant as playing a role in their professional collaborations. These interviews gave a deeper understanding to the factors that teachers describe as supporting or hindering continued lesson study efforts.

Lastly, some participants participated in interviews after learning about the opportunity after one of their peers was interviewed. For example, a former grant teacher saw a researcher set up equipment to interview their fellow teacher. This interaction led to the teacher expressing a willingness to be interviewed. These teachers were not re-invited to take the online survey since they were invited via email multiple times.

Online Survey

The online survey was administered online during October 2013 to inquire about teachers' status with lesson study. Teachers could take the survey when it was convenient for them. For participation in the online survey, teachers received a \$10 gift card.

Relevance of Online Survey to Research Questions.

Practically, the online survey data was used to invite participants to engage in a semi-structured follow-up interviews.

Theoretically, the online survey data was used to triangulate interview findings about research question (2) on what practices of lesson study continued at participant

sites and research question (3) on factors that supported and constrained teachers' ability to continue to engage in lesson study. The online survey asked participants through multiple choice and short response questions if they have completed a round of lesson study. Participants elaborated on their multiple choice selection, providing avenues of insight into research question (2) on what practices of lesson study have continued. For research question (3) on factors that supported and constrained teachers' ability to continue lesson study, participants selected from a list of possible answers or wrote their own reasons in. Options included whether their school arranged time for collaboration or provided other resources, whether a culture of collaborative inquiry was established at their site, whether teachers collaborate virtually, or whether they can observe other teachers. They also had an option to write in solutions.

Sustainability Interview

The sustainability interviews with teachers and principals were audio and video recorded in the participant's classroom, office, or workroom, with the camera pointed at the upper portion of the participant's body. A second camera located on a computer was directed at the interviewer to serve as back-up audio. Sustainability interviews were collected as early as December 2013 and as late as July 2014 to accommodate the schedules of the participants.

TOSA interviews with Kimmy and Diana were collected twice each – once during September 2013 shortly after the start of the academic school year and second during the middle of the school year. These interviews served to collect general information on what teachers were experiencing with respect to teacher collaboration, Common Core implementation, district workshops and trainings at different points in

the year. Interviews with Kimmy and Dianna were important for locating groups of teachers interested in continuing lesson study and identifying support from principals. For participation in the sustainability interview, teachers received a \$30 gift card.

Relevance of Sustainability Interview to Research Questions.

Participants' responses gave insight to each of the three research questions both through implicit and explicit answers to questions. Interview data gave clear insight into teachers' conceptions of what it means to engage in lesson study and the usefulness of lesson study through a number of its questions. Interview data gave insight into teachers' practices since it asked about the nature of activities with those with whom they collaborated. Finally, through applying the framework of sustainability, I was able to use the interview data to analyze factors that support and constrain teachers' ability to continue lesson study.

Field Notes

Field note and analytic memos served as secondary data sources that helped to triangulate claims reported by participants during the sustainability interviews. Field notes were collected during the Fall of 2013 when visiting teacher meetings by myself. These school visits occurred weekly from September through December on Thursdays during collaboration time for fifth-grade teachers. These field notes were relevant for three reasons. One, it allowed me to experience the nature of teacher collaboration activities that three of the five teachers would later report on during a sustainability interview, and thus confirm findings in interviews. Two, collecting field note data and attending meetings allowed me to continue a professional relationship with teachers. This would allow for the data collection of interviews to be more naturalistic with an

established relationship. Three, collecting these field notes allowed me deeper insight into the institutional settings that I was interested in studying. Other notes like contact forms included verbal records of contact forms created by myself and oftentimes with another researcher after collecting data. These memos allowed me to summarize findings from an interview, hypothesize themes, and reflect on emerging themes or tests of hypotheses. It also served to redirect my focus to my research questions and highlight important themes to highlight or probe for the next interview. Additionally, any modifications to interview protocol were recorded in the memo so that the researchers could make modifications for the next data collection.

Data Reduction

As previously described, I engaged in preliminary analyses of the interview data using contact forms to decide which interviews to analyze in greater depth while collecting data. To make these decisions, I revisited contact forms and components of interviews with TOSAs Kimmy and Dianna, who both reported information about lesson study in each district.

After revisiting these data sources, I prioritized data collection in two ways. First, I chose to analyze interviews at sites where a high number of participants agreed to participate in this study. This allowed me to form a rich description of teacher collaboration at a site by using other participant interviews to confirm participant reports. Second, I chose to analyze participant interviews that showed evidence of being likely to continue lesson study at their site as reported by TOSA interviews. Preliminary evidence that showed a likelihood of continuing lesson study included principal support as expressed by TOSAs, teachers' expressed interest in continuing

lesson study as inferred from a teacher's survey data, interview data, and TOSA interview data. Since my research question also targets factors that hinder the sustainability of lesson study, I also prioritized data analysis on interviews that showed evidence of not being likely to continue less study at a site. Selecting a range of likelihood for continuing lesson study ensured that I answered my research question that sought factors that both supported and hindered teachers' ability to continue lesson study.

This data reduction resulted in twelve teachers, three principals, and two district TOSAs for a total of 17 participants. See Table 3-1 for a list of participants by site analyzed for this study.

Data was further reduced during the analysis period by 1 teacher (third-grade teacher Ceci) for reasons that will be discussed under Data Analysis.

Data Analysis

Having described the data to be collected and the procedures for its collection, I now turn to a description of how the data were analyzed. I first describe an overview of the methods used to answer the research questions. I then specify how each of my research questions was analyzed.

Overview

I used single and multiple case study methods to understand teachers' accounts as they are embedded in institutional settings (Stake, 1995; Stake, 2005; Yin, 2008). In these methods, semi-structured interviews were used as a way to understand teachers' accounts and the institutional setting. Based off of a clinical interview, which is defined as a social interactional encounter between an interviewer with a particular

agenda and a subject (diSessa, 2007), semi-structured interviews were designed with tailored follow-up questions.

I also use methods from grounded theory to create emergent codes grounded in my data to search for themes in the data (Strauss & Corbin, 1994). Grounded theory is an approach towards research whose inductively derived theory emerges from the study's data. Grounded theory encompasses several types of coding processes. The themes that emerged from performing open coding on an interview were compared and contrasted to those themes found through open coding on other interviews. Themes were collapsed or differentiated during axial coding, and then applied to other interview data. After emergent codes were created and applied to all interviews, generalizations across interviews were drawn by comparing codes and identifying themes through axial coding. Research question (3) about factors that supported and constrained teachers' ability to continue lesson study was answered in part by reporting on themes within the integration, linkage, and synergy framework.

Finally, I use social network theory to conceptualize and document one aspect of social resources, linkage, in order to understand how individual actors were embedded in social structures (Carolan, 2014; Daly, 2010). I follow Carolan's (2014) work on egocentric network analyses, which involve networks of participants connected based on who they describe (as opposed to placing everyone in a network regardless of if they were reported by a participant) to analyze relationships among connected individual actors embedded in social structures. As Carolan wrote, "Egocentric analysis shifts the analytical lens onto a sole ego actor and concentrates on the local pattern of relations in which that ego is embedded as well as the types of

resources to which those relations provide access” (p. 140). Utilizing this analytic technique allowed me to quantify the integration (connections within a group) and linkage (connections to resources and people outside of a group) attributes of a network.

In sum, I answered research question (1) on factors that support and hinder continuing lesson study in two ways: analyzing results from applying a modified version of the sustainability framework to the interview data and applying grounded theory to participants’ interview and online survey responses. Research question (2) regarding practices of lesson study that were reported to have continued was addressed using a priori, or existing, codes corresponding to the different components of lesson study as described in the literature, like investigating and goal setting, planning the research lesson, teaching and observing the research lesson, debriefing the research lesson, and optionally modifying and reteaching the research lesson. Also, the presence of anticipating and responding to thinking was another a priori code used to gauge practices of lesson study due to its central role it plays. Research question (3) was addressed using techniques of grounded theory to identify and categorize themes in teachers’ understandings of lesson study.

I now discuss analysis methods by chapter and the respective research question that each type of analysis addresses.

Analyzing Resources in Chapter 4

Because resources are important for shaping the presence, nature, and direction of teacher collaboration, I began my analyses by reporting on the types of resources that were reported by participants. To analyze resources that supported teachers’ work,

I coded interview data by material, human, and social resources as described in Chapter 2. I labeled all instances of reported resources, categorized it as either material, human, and/or material resource, and described how each of these resources were used. Questions from the interview protocol that elicited resources that supported teacher collaboration during coding included questions on the resources provided by the teacher's site or the district to support collaboration. All teacher and principal interviews from a site, when possible, supported the report on resources.

One can draw a distinction between resources that are available to teachers and resources that are utilized by teachers. I follow Gamoran and colleagues' (2003) emphasis of access to resources.

As described in Chapter 2, material resources include information or items that can be exchanged among people. Examples of material resources include paid time for collaboration either during or after school hours, access to textbooks like the Van de Walle and Lovin's (2005) *Teaching Student-Centered Mathematics* that was frequently referenced during Project X to design lessons, and technology like iPads and access to the internet. I considered these examples of material resources since they can be purchased for money. Human resources include qualities of individuals that can be exchanged, like knowledge of the Common Core framework, skill about mathematics from previously teaching mathematics, and district trainings on the Common Core State Standards for Mathematics or lesson study. Social resources include the attributes that result from roles or relationships among people, like the development of common purposes, shared norms, and expectations. Examples of social resources include the shared goal of systematically inquiring into teachers'

mathematics practice and trust among teachers with professional relationships. These are social resources since these are attributes located within relationships among people that help to attract other resources like material and human resources. Note that each resource may attract other resources, such as material resources attracting other material resources, human resources attracting material resources, and social resources attracting both material and human resources.

Operationalizing the construct of material resources involved labeling physical materials or materials, like time, that could be purchased for money. Coding human resources involved noting the qualities of an individual that can be exchanged among people, like knowledge of mathematics or the skill of connecting different mathematical content. For the purpose of this chapter, I operationalized social resources by limiting my analyses to reports of connections to resources, people, or groups. I also coded relationships that provided material or human resources as social resources. The purpose of coding for social resources was to provide evidence of networks of teachers existing or not existing so that further analyses could occur using the sustainability framework in Chapter 5.

Due to this study's goal of understanding sustainability by unpacking social resources like linkage, integration, and synergy, results on types and uses of resources helped prepare for the further reporting and elaborating on social resources using a modified version of the sustainability framework.

Analyzing Sustainability in Chapter 5

The analytical framework used to answer in part research question (3) on factors that supported and constrained teachers' ability to continue lesson study

involved Gamoran and colleagues' (2003) sustainability framework. They used Woolcock's (1996) social capital framework for economic development and applied it to an educational context. I analyzed data delineated by linkage, integration, and synergy for themes within each of these components. Results in this chapter lie within one of those three parts of the sustainability framework.

Important to using this framework is its focus on groups of individuals. Each of the constructs of integration, linkage, and synergy involve qualities of a group of people situated within a larger institution. In this study, the groups are groups of teachers, and the larger institution is either the school or district. Social network theory allowed me to operationalize linkage, a component of the sustainability framework, by examining relationships among actors in a network social network analysis. By examining ties within informal and formal groups of teachers, I was able to quantify in part linkage.

As described in Chapter 2, *integration* is shared values, mutual expectations, levels of trust, and norms; *linkage* refers to social relations that attract resources; and *synergy* refers to whether the efforts of the teacher community is aligned with the efforts of the school and district. I chose to modify the framework by removing organizational integrity due to the lack of evidence that confirmed the effectiveness of an organization at distributing human and material resources. This could be attributed to the fact that many participants noted about the current year being a transition to Common Core year. Additionally, the design of this study did not allow for a way to measure effectiveness of resource allocation. As will be noted in Chapter 4, many teachers described access to minimal resources. Due to the goal of this study to

develop a deeper understanding of the sustainability of lesson study rather than evaluate the effectiveness of a program, analyzing organizational integrity did not fit and consequently was not used as part of my analytical framework.⁴

I now describe in detail how I analyzed using the three conditions of the modified sustainability framework.

Integration & Linkage.

Recall that integration refers to the shared values, norms, and goals of a group. Gamoran and colleagues (2003) described that integration provides both a collective focus on goals and aims, as well as opportunities for professional collaboration. Integration is embedded in an institutional context that both supports and constrains the context as it interacts with integration.

Characteristics of a group, some formally arranged and some informally arranged, were implicitly and explicitly hypothesized with individual interview data, survey data, and field note data. These analyses brought together multiple perspectives to describe groups and the settings within which these groups sit. It is particularly important to consider multiple participants. Because lesson study is a teacher-led activity wherein educators meet to inquiry systematically into their practice, research that seeks to better understand teacher and principal perspectives about lesson study, and not necessarily the researcher's perspective that relies on field notes and shadowing experiences, can give great insight to supporting lesson study. Multiple

⁴ Interestingly, a note in Gamoran and colleagues' (2003) table came to a similar conclusion. They noted that there were not enough items on their survey relating to organizational integrity to productively describe it with a scale. Even with both survey and interview data, the concept of organizational integrity did not fit the context of my study.

perspectives also provide a triangulation of data (Miles & Huberman, 1994).

Interviews with administration served as a way to triangulate what teacher participants said and to make the data more rich.

To analyze integration, I first created an initial conjectured connections graph based on participants reports of those teachers with whom they worked. I created undirected graphs, or sets of *vertices* representing individuals and undirected *edges* representing activities between two individuals, with the inferred social network data. I placed an edge between two vertices if at least one of the two participants represented by vertices described engaging with the other in a meaningful way. To decide whether a reported connection was meaningful, I looked for multiple instances of someone mentioning another person, nature of interaction, and depth of the interaction. I also sought to attend to the difference between “collaborative cultures and contrived congeniality” when examining the nature of the interaction (Hargreaves, 1994). Sometimes only one person in a pair of participants reported working together. Other times both participants reported working together. These initial conjectured connections served as the first pass at identifying groups of participants.

After creating initial conjectured connection graphs, or linkage graphs, based on participants reporting on with whom they work, I then analyzed the activities of linked participants using grounded theory analyses on interview data and field notes. Codes emerged from engaging in open coding on data sets, grouping similar themes together, and comparing codes against other data. These codes also served as analytical tools to analyze sustaining practices.

I then used the initial conjectured linkage graphs and along with grounded

theory codes on their activities to modify and update group structures. I iterated this process several times until reaching a consensus on group membership. Groups included formally and informally arranged groups. Formal groups included grade-level groups organized by institutional settings whereas informal groups included groups of collaboration. An informal group is presented in Chapter 5 that consisted of five Project X members across two grade levels who reported collaborating with each other.

After iterative testing of these conjectures about group membership against discriminating data, I then systematically analyzed a given group for integration themes. Specifically, I analyzed groups for evidence of trust, mutual expectations, shared values, and potential for establishing norms using TAMSanalyzer®. Integration codes emerged from engaging in grounded theory analyses (Strauss & Corbin, 1990) that involved open coding the data, grouping similar themes together, and comparing codes against other data. Reports from individuals within each group were compared against other group member responses to ascertain a level of integration with respect to each group.

Recall that linkage refers to social relations that attract resources. To analyze linkage, I sought to understand a participant's connection to key resources, people, and groups that served as resources. This was reasonable since a major focus of each interview surrounded with whom each participant collaborated and the types of activities in which they engaged.

I used four criteria to decide what constituted a group when analyzing interview data. First, I restricted groups to current relationships and activities

described by participants. For instance, Mia describing that she worked with Nikki during Project X the previous school year but not the current school year would not satisfy being a current relationship. On the other hand, Mia describing that she converses with Carmen, Jimmy, and Ben once a week both informally and formally satisfies being in a current relationship.

Second, I restricted groups to require participants describing activities with intentions to focus on teaching and learning mathematics. Due to the focus of this dissertation on mathematics teachers' experiences with lesson study to improve their teaching practice and factors that would support these teachers in continuing to do so, I limit groups to focus on issues surrounding the teaching and learning of mathematics. In some cases, teaching and learning activities were coded that did not explicitly state a mathematical nature to the focus of the activity. If these activities were useful in understanding a lack of conversation about mathematics, I included it to learn more about the potential to focus on the learning and teaching of mathematics. For instance, I coded the following as "nature of collaboration - conversing" since this helped show that topics of conversation were not always revisited:

{NOC_Meeting} And meetings would be so much more effective if just everybody had a common goal. [00:34:57.05] Nothing else got in the way. {NOC_Conversing} Okay, this, for the next five weeks, we're going to talk about this [during the meeting]. Everybody, you know, bring your ideas. Bring something. But we don't, so. {/NOC_Conversing} {/NOC_Meeting}

Third, I restricted groups to include relationships among people with some specific reference to activity in order to support my claim. I conservatively restricted claims about the members of the group due to the study including only former Project

X participants and not each grade level teacher at each site.

Lastly, I determined groups with evidence of at least one of the group members describing some form of collaboration with another member. This pair would be (part of) a group even if the person did not explicitly reference the first person. These four criteria - a focus on current relationships, a focus on activities geared towards teaching and learning mathematics, a focus on relationships reported by participants, and an undirected graph without requiring that both participants described the activity - guided the process of deciding groups of teachers among participants.

For example, four professional groups were elicited from multiple data sources in Case 1, including two formally arranged grade-level groups (GLGs) for the fourth and fifth-grade teachers, and two informal professional learning communities (PLCs), including one subgroup of a grade-level group and one multi-grade level group, both consisting of former Project X grant members. As mentioned previously, groups were determined through analyzing social network theory data that described with whom each person worked and/or collaborated.

Several issues arose when defining groups. Sometimes people referred to a group of people and not an individual. A preference was held over data that could explicate a particular person rather than refer to working with all second grade teachers or all teacher leaders. Sometimes people referred to engaging in a range of activities, where each activity might vary in its frequency. For instance, some teachers described conversing multiple times a week with one another about teaching particular mathematics topics, while others described one instance of observing another teacher teaching mathematics during the school year. Both activities, though engaged in with

varying frequencies, satisfy the four criterion of focusing on activities geared towards teaching and learning mathematics. Thus, the activities represented by edges were not weighted edges. Another issue surrounded how I distinguished coding data that explicitly stated that they worked with someone else to do the activity and those activities that lacked a direct link with a person. Though I prioritized coding activities among two or more people, I also coded activities that teachers engaged in by themselves if it suggested something about the nature of how a teacher collaborated. This allowed me to capture the nature of activities more richly.

In addition to analyzing groups along these four criteria was whether a group met requirements to be called a PLC. The criteria used for determining PLCs followed Westheimer's (1999) definition of a community: shared beliefs and understandings, interaction and participation, interdependence, concern for individual and minority views, and meaningful relationships. Thus, if these PLC criteria were present, a group could be called a PLC. If not, the group was simply referred to as a group.

Synergy.

Synergy, or the alignment of a group's goals to those of the larger setting like the site or district, was analyzed using similar methods to integration. I prioritized analysis of questions that asked participants if they believed that the goals of their particular group aligned to the goals of the district. Questions that asked about the types of resources that supported their group often elicited information about participants' views of the district since the district was one source of resources. Additionally, survey data were analyzed for synergy in the instance where a teacher in one of the case studies also completed an online survey. Recall that these online

survey questions targeted whether individual participants believed the principal and district supported innovation about instruction at their site and district. Together, these questions were analyzed using grounded theory techniques to analyze the synergy of groups situated within larger institutions.

Summary of Analyzing Sustainability Framework.

In summary, I used the sustainability framework to guide my analyses on both the factors that support and hinder teachers' ability to continue to engage in lesson study and to determine the nature of practices of lesson study that were reported to have continued. The modified sustainability framework involved the conditions called integration, linkage, and synergy. Additionally, I used social network theory to operationalize the linkage condition of the sustainability framework. I now discuss social network theory in greater depth.

Social Network Theory

A growing number of educational researchers are using theoretical and methodological techniques from social network theory (Carolan, 2014; Daly, 2013). I follow Carolan's (2014) work on social network theory to analyze how individual actors are embedded in social structures, examining their relationships in addition to attributes of individuals. "Egocentric analysis shifts the analytical lens onto a sole ego actor and concentrates on the local pattern of relations in which that ego is embedded as well as the types of resources to which those relations provide access" (p. 140). As also previously described, I utilize this analytic technique to quantify the integration (connections to local group) and linkage (connections to resources and people outside of a group) attributes of a network.

Egocentric social network data were derived from interview data. It is comprised of *egos*, which are the individual actors interviewed as a participant in my study, *alters*, the individuals and/or groups described by the ego, and *edges* between two actors signifying a relationship. Undirected edges signify a perceived relationship between a pair of actors as described by at least one of the actors in the pair. That is, both actors do not need to describe the same relationship for edges to be placed. Each edge signifies professional relationships for which there is data describing the nature of interactions to the described alter.

Though many social relationships might exist between two people, such as behavioral interactions (talking to each other), physical connection (eating in the same lunch space), affiliation (belonging to the same group), evaluation of one person by another (considering a person a friend or an enemy), and formal relations (a person having authority over another), I focused my analyses on social relationships mostly on behavioral interactions, affiliation, and formal relations.

I follow Carolan's (2014) definition of social network, which is a group of individuals and the relations defined on these individuals. Importantly, social network analysis centers not just on the individuals themselves but on the ties among individuals. Carolan described four distinguishing features of social network analysis to include: (a) a strong focus on structure, or the embedded patterns of relations within and between groups, (b) a systematic collection and analysis of empirical data, (c) graphical imagery as an important tool, and (d) mathematical models to obtain high levels of objectivity (Freeman, as cited in Carolan, 2014).

Social network analysis has not been used as often in educational research as some other areas of research (Carolan, 2014). Three reasons hypothesized for this include a dominance of the individual and psychological perspective to studying educational processes and outcomes (e.g. that motivation is rooted in the individual as suggested in the behaviorist tradition), a search for educational researchers and their work to be legitimate (adopt traditions of science and collect random samples of individuals disconnected to their context), and a preference for researchers to use qualitative research methods to combat questions regarding quality and relevance of educational research.

There are four analytical levels of networks. The first and most simple is an egocentric network, which consists of an actor (called the ego) and all other actors with who the ego has a direct relation. This set of actors related to the ego are called the ego's first-order contacts, or friends, and including friends of the friends of the ego is referred to as the ego's second-order contacts, etc. The second level of networks is a dyad of actors. The type of question suited for this level of network is whether a tie exists between any two actors, and what is its frequency or duration. Results from this type of network analyses usually report on changes in dyadic relations in terms of characteristics of the dyad. The third level of networks is a triad of actors. The type of question suited for this level of network are those that examine the types of ties among three actors, which has up to 16 ties and non-ties combinations. The fourth level of networks is a complete (whole or full) network. Complete networks involve all actors and their ties among each other. For this study, I use egocentric networks.

Two main methods through which egocentric data can emerge are through surveys asking respondents to identify other people that they share a relationship with or by extracting them from a complete network study. The first method, using a sociometric survey administered to a sample of people or a snowball approach, may involve a snowball approach where each person identifies others that they share a relationship with. These people are then asked to take the survey, with the process repeating. The second method, from complete network studies, occurs when a researcher extracts all samples of data that share a common theme, for instance, untenured faculty at a university. Carolan (2014) notes that the denser the complete networks where data is sampled, the better since one's ego network will overlap with another.

Early studies on social relationships concluded that social relationships are important to study because to whom people have a direct relationship have an effect on a person's beliefs and actions. There are three assumptions inherent to social network analysis, or pattern relations and their effects. First, social relations are often more important to study than attributes of a person's background (e.g. age and gender) when trying to understand beliefs and understandings. Second, social networks affect beliefs, perceptions, and behaviors through the structure of a social network that is created through the ties of the actors. Third, relations are part of a dynamic, and not static, process where relations shift as actors engage with others in shifting contexts. Educational researchers have used social network analysis with respect to the areas of social capital, diffusion, and peer influence.

Analyzing What Sustained in Chapter 6

To answer research question (1) on the practices of lesson study that were

sustained, I coded linkage data, which is the type of activity described by participants, using a priori codes of the components of lesson study. Primary questions from interview data analyzed to answer what practices sustained included: participants' descriptions on the nature of activities engaged in with colleagues, descriptions about whether a round of lesson study continued, and other general activities reported by participants.

Analyzing Conceptions of Lesson Study in Chapter 7

I viewed teachers' conceptions of lesson study as an important subset of integration since it centered on understanding teachers' values, expectations, and norms associated with lesson study.

To answer research question (2) on participants' conceptions of lesson study, I analyzed interview data in which teachers were asked to describe what occurs during a cycle of lesson study, how they would describe lesson study to a friend who has not participated, and what lesson study was useful for. Teachers' conceptions were grouped according to the groups in which they were members as described in Chapter 5. Conceptions were coded using emergent codes from grounded theory analyses along two themes: (a) the *structure* or protocol associated to engaging in lesson study, and (b) the *focus* or purpose of the described structure or nature of activities. I also analyzed factors that teachers reported would support continuing lesson study using emergent codes from grounded theory. Questions like, "What resources would support lesson study?", "Would you make any changes to lesson study?", and "What issues are you dealing with in trying to move forward?" were closely analyzed for themes with grounded theory to further answer the question. I summarized these factors at the end

of teachers conceptions.

Final Analysis on Factors that Support and Hinder Lesson Study

To formally finish the answer research question (3) on the factors that supported and hindered lesson study, I synthesized results about resources in Chapter 4, the sustainability framework in Chapter 5, practices that sustained in Chapter 6, and teachers' conceptions of lesson study in Chapter 7 using multi-case study analyses. I contrasted levels of linkage, integration, organizational integrity, and synergy across four cases to see factors that would support lesson study continuing for particular groups and hinder others. I also contrasted teachers' conceptions of lesson study across the cases.

Validity and Reliability

In this section, I describe measures that I took in the interest of the validity and reliability of the study. Although this study involved mixed methods, the purpose was to understand deeply the nature of teachers' collaborations to discover what would sustain lesson study as a form of professional development. Therefore, the main methods used to ensure validity and reliability fall under qualitative research programs.

Validity

To assess the validity of my study, or as Maxwell (2005) calls "the relationship of your conclusions to reality" (p. 105), I report here on the ways that I made efforts to rule out validity threats and alternative interpretations of my data. To demonstrate the validity of my conclusions drawn from evidence, I discuss researcher bias and the researcher's affect on individuals in my study (Maxwell, 2005).

First, I attempted to as clearly as possible state my researcher bias and how I dealt with these during data collection and analyses to address reactivity, or the influence I might have on my participants or the setting (Maxwell, 2005). Researcher bias refers to both the selection of data by the researcher that fits with their preexisting theory and any data that “stands out” to the researcher. As eliminating a researcher’s beliefs and perceptions is impossible (Maxwell, 2005), I sought to clearly describe my personal values and beliefs. Working as a research assistant on the former grant for two years prior to data collection for this study, I was able to experience with teachers a full cycle of a lesson study – planning, teaching, observing, and debriefing. These shared experiences initially struck me as interesting. Over the course of two years, I observed the teachers gradually noticing and arguing on aspects of the lesson study that I myself was curious about. I was also able to listen to participants reflect on the lesson study process during their cycles. During these times, I was able to infer teachers’ levels of enjoyment. This led me to conclude that teachers participating together to inquire into their own teaching practice in a way that centered on student thinking was productive and merited more study. My belief that teachers could learn productively when they collaborate was thus greatly rooted in my experience prior to this study. That lesson study could be productive for many teachers and that collaborating to learn more about the teaching practice are my personal values that shaped my personal lens that I used to analyze data.

Another important way my study provided a thorough understanding of what occurred was through triangulating rich data from a range of data sources and using a range of data collection methods (Maxwell, 2005; Stake, 1996). For example, I

triangulated findings from analyses with multiple data sources such as interview data, field note data, and direct observation. This helped me ascertain certain claims. For instance, I was able to ascertain with a high level of certainty the nature of support the principal gave to his teachers by seeing if the teachers at his site cited him as a resource and in what ways.

Finally, I assessed validity occurred by using respondent validation, or member checks. To do so, I asked a member of the study to review analyses about resources that supported teacher collaboration. After reading analyses, we discussed inconsistencies, which centered on providing a more complete story on the origination of and purposes for particular resources. Performing member checks helped me seek out perspectives that could challenge and refine my findings about resources that supported teacher collaboration.

Note that I met with other mathematics education researchers to discuss themes in the data as I collected it and analyzed it. As analysis proceeded, meetings with one or two of these researchers increased so that my findings and approach could be questioned and solidified.

Reliability

To address issues of reliability, or whether other observers would agree to what occurred in a setting, I used field notes data from direct observation, interview data from other participants, and educational objects like lesson plans and email communication to triangulate findings from analyses. The design of this study allowed for multiple perspectives, like perspectives of teachers in a similar group, principals at teachers sites, and the TOSA co-investigator Kimmy, to be analyzed and combined to

describe groups.

Summary of Validity and Reliability

To address issues of validity and reliability, I stated my researcher bias and use a constant method of data triangulation through the use of other data sources (like interviews with others, field notes, and researcher memos). I also presented results to a member of the study to check that my information was presented truthfully.

Conclusion

To better understand what would support teachers in continuing to engage in lesson study after external funding from a grant ends, I collected survey data, interview data, field notes, and educational objects from teachers, principals, and district TOSAs. I first analyzed participants' reported material, human and social resources to support teacher collaboration by coding the presence of each within sustainability interview data for teachers, principals, and TOSAs. I then operationalized social resources through using the sustainability framework. To apply the sustainability framework to my data, I used both social network analysis and grounded theory techniques. I used social network theory to analyze a component of the sustainability framework – linkage – which helped to both quantify levels of connectedness and qualify the nature of activities engaged in. Identifying linkage and integration was a reflexive process – initial analyses of linkage informed integration, and integration analyses confirmed or disconfirmed initial reports of linkages by participants. Grounded theory was used to examine themes within integration, linkage, and synergy. Additionally, survey data were analyzed for synergy since questions targeted whether individual participants believed the principal and district to support

innovation about instruction at their site and district. This analysis helped to answer research question (3) about what supported and hindered teachers' ability to continue with lesson study.

I next analyzed what aspects or components of lesson study were reported to have sustained. I used a priori codes from the literature about components of lesson study to categorize those practices of lesson study reported by participants to have sustained across interview, survey, field note, and educational object data. Then, I coded participants' reported conceptions of lesson study. I viewed teachers' conceptions of lesson study as a subset of integration since a conception of lesson study can be viewed as a shared norm. Also in this section, I focused on participants' reported factors that they believed would support and constrain their ability to continue lesson study. This analysis helped to answer research question (2) on conceptions of lesson study.

Finally, I utilized multi-case study analyses to compare cases and their respective groups around each of the research questions. Specifically, I compared and contrasted resources that supported their teaching, themes in the data derived from the sustainability framework, practices or components of lesson study that were reported to continue, and finally, to compare teachers' conceptions of lesson study. See Figure 3-1.

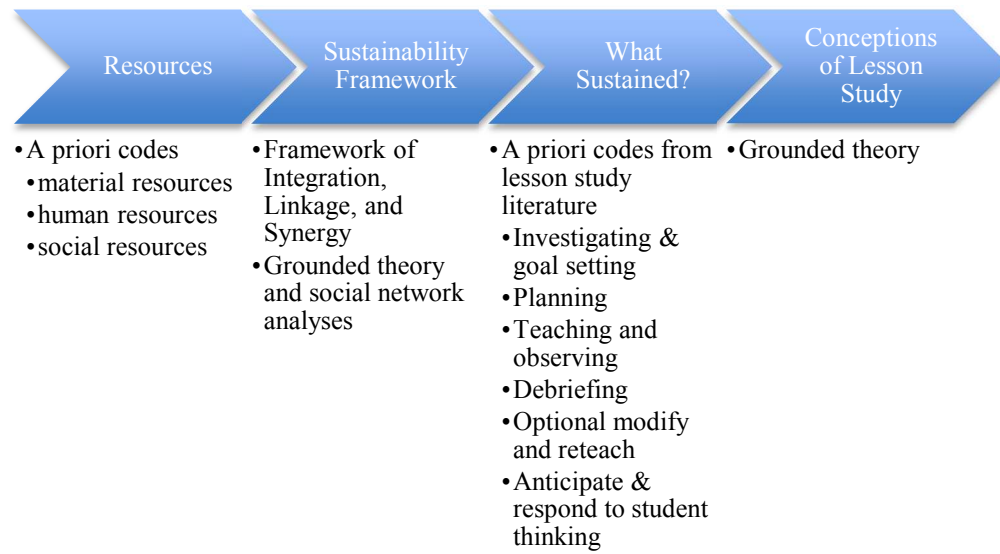


Figure 3-1. Graphic of the sequence of research questions.

Chapter 4: Results on Resources

People think of resources a lot of times as, ‘What can I buy the teacher? What book can I buy this teacher to make this teacher a better?’ Or what program can I buy this teacher that will suddenly like, fix their pedagogy, and they will suddenly become this amazing Common Core teacher? But you're asking, you know, teachers to do things that have to happen internally within them.

- 4th grade teacher Carmen

Now that I have introduced the study and research questions in Chapter 1, summarized relevant research and theory that focused my inquiry in Chapter 2, and described methods used to answer my research questions in Chapter 3, I now present the first results chapter. To make sense of answers the research (1) what factors supported and constrained mathematics teachers’ ability to continue lesson study after the end of the grant, and question (2) on what practices of lesson study continued past the end of the grant, I first report results on resources that support teacher collaboration.

Gamoran and colleagues (2003) argued that creating a capacity for change required a number of resources, including material, human, and social resources.

Developing a capacity for change means providing not only material resources such as time, curriculum, supplies, and equipment, but human resources, including knowledge, skills, and commitments, and social resources, such as the interpersonal relationships that teachers draw upon to develop and sustain new norms of practice (p. 174).

They argued teacher professional development to be the main impetus for change because “it alters the nature and distribution of resources in a district and its schools”(p. 174). Districts need to not just see resource allocation as controlling resources, but more importantly, to see resource allocation as building an organization

as a response to teachers' efforts and initiative. These resources – material resources like time and curricular materials, human resources like expertise outside and inside the schools, and social resources like communities and catalysts – must be developed within an organization for it to continue to grow. Importantly, meeting the challenge of sustaining professional development as ongoing, coherent, and generative involves creating and maintaining relationships and flows between those directly involved and groups in the broader community, which help to attract material and human resources.

It is important to understand not only the resources themselves – like physical objects, skills and knowledge, and qualities of relationships like shared values, norms, and trust – but also the ways in which the resources are used, by whom, and for what purposes. It is not enough to know that they exist. As fifth-grade teacher Jimmy noted, “I think whether we use them [resources] or not is, you know, is another story.”

In this chapter, I describe the institutional context in terms of material, human, and social resources that supported teacher collaboration as reported by participants in each of the four cases. In Chapter 5, I expand on social resources using Gamoran and colleagues' (2003) modified sustainability framework of integration, linkage, and synergy across each of the four sites. Doing so allowed me to examine social relationships and ties that attract other resources, or as Gamoran (2003) stated, “communities and catalysts”(p. 72), to see how communities can sustain generative change.

The following results were reported by teacher and district administrators by analyzing both interview and survey data. Participants comprised four cases involving

seventeen participants (twelve teachers, three principals, and two TOSAs)⁵ across two districts. After Chapter 4, one of these teacher participants in Case 4 (Ceci) will not be included in analyses because of the focus on other groups within the case studies. See Table 4-1 for a list of participants and their respective locations.

Table 4-1. Summary of participants analyzed for resources by case.

Case	District	Participants (teacher/principal/district)
1	Long Pond	Bertha (fourth-grade) Carmen (fourth-grade) Jimmy (fifth-grade) Ben (fifth-grade) Mia (fifth-grade) Principal Ron TOSA & former grant co-PI Kimmy
2	Sun Valley	Anita (eighth-grade resource specialist program) Kamille (seventh-grade mathematics) Nancy (sixth-grade mathematics) Principal Kate TOSA mathematics coach Dianna
3	Long Pond	Tonya (seventh-grade)
4	Sun Valley	Kerry (fifth-grade) Don (fifth-grade) Ceci (third-grade) Principal Paula TOSA mathematics coach Dianna

Results on Material, Human, and Social Resources That Support Teacher Collaboration

In her quote at the beginning of this chapter, Carmen is expressing that professional development and support for teachers is often seen uni-directionally in terms of providing resources to develop human resources. What she hints at is the

⁵ I chose to present four cases to illustrate the spectrum of contexts. A case is situated at a site but may encompass others situated within the same district, like TOSAs working at multiple sites in a district.

need for a bidirectional flow of resources with other ways to develop human resources, with resources such as social resources that help teachers to attract other material and human resources.

As Table 4-1 described, Cases 1 and 3 were located in Long Pond school district and Cases 2 and 4 were located in Sun Valley school district. Long Pond and Sun Valley school districts shared a number of similarities. Both districts were equally represented in the Project X grant, with teacher and math coach participants spanning a number of the 18 roughly four-person lesson study groups. Unsurprisingly, districts focused on implementing Common Core Standards during the time of this study, as confirmed by mathematics coaches, district administrators, principals, and teachers. Both districts hired Teachers on Special Assignment (TOSAs) to serve as coaches who helped to implement the new mathematics standards and in some cases other standards like English language arts. Both hired teachers, such as physical education (PE) teachers in Long Pond and visual and performing arts (VAPA) teachers in Sun Valley, to allow teachers more collaboration time during school hours for professional learning communities (PLCs)⁶. Prior to the year in which the research was conducted, PLC time was not practiced district-wide and only practiced if schools could afford it and/or chose to do it, typically Title I schools. New to the current year, grades 1 through 5 teachers received approximately 50 minutes for weekly professional collaboration time.

Both districts turned to local teachers in their district to create curriculum materials that aligned to the new Common Core Standards, with the intent to use this

⁶ PLC time is time (typically 50 minutes) allotted each week for grade-level teachers to meet.

teacher-created curriculum until the district purchased a commercial curriculum.

Teachers in Long Pond were preparing to make modules for units during the summer of 2014 (towards the end of data collection for this study), and teachers in Sun Valley created unit planning organizers that grouped targeted standards for each unit during the summer of 2013 (towards the beginning of data collection for this study).

Additionally, all three principals in these case studies described that the contracted PLC time was to be teacher-led and driven, without the principal dictating the nature of the PLC agendas. Both districts invited teams of teachers to train at the district at the beginning of the school year, though the purposes differed. In Long Pond, teachers from each grade-level at every school were invited to engage in a district-led lesson study with the goal of preparing the teachers to lead lesson studies with each of their respective grade-level group of teachers. In Sun Valley, teachers from each grade-level at every school were invited to join a district-wide leadership PLC with the goal of understanding the Common Core Standards.

Sun Valley differed from Long Pond in an important way. This district placed an emphasis on a district-wide leadership PLC. To do so, the district invite one teacher leader from each grade-level from every site along with their principal. The purpose of the team was to train teacher leaders in Common Core so that these teachers could return to their site and lead their grade-level in unpacking the Common Core Standards. Thus, each district focused on sending a team of teacher leaders from each school (one from each grade level) but the focus at Long Pond was specifically lesson study.

I now describe reported resources from each of the four cases.

Case 1 Resources for Collaboration

Bertha and Carmen were fourth-grade teachers at Milk Elementary School, and Jimmy, Ben, and Mia are fifth-grade teachers at Milk Elementary School. Bertha and Jimmy served as the formal teacher leaders of each of their respective grade-levels. Bertha and Carmen were two of the four fourth-grade teachers, with one of these other two teachers a former Project X teacher not interviewed for this study. At the fifth-grade-level, Jimmy, Ben, and Mia represented three of the five fifth-grade teachers, with the other two teachers not Project X teachers.

Table 4-2 summarizes the resources for participants at Case 1. I now give evidence to support these claims.

Table 4-2 Summary of resources at Case 1 in Long Pond.

Type of Resource	Described by Participants
Material	time (weekly 50 minutes grade-level meetings, additional release time from principal), curricular materials (mathematics books, websites, the CCSS framework, and articles), and technology (iPads) and manipulatives
Human	district trainings about CCSS math standards, teaching students using performance tasks, and lesson study; shared experiences and values from Project X; Principal’s knowledge about mathematics, pedagogy, and the CCSS framework; qualities of teachers (Carmen’s ability to unpack mathematics and relate “what comes next”, Ben’s knowledge of research, Todd for brainstorming ideas); and Kimmy’s knowledge of pedagogy and how to navigate the district
Social	shared norms, values, and language among teachers; and networks (friends, former Project X teachers, non-Project X teachers, principal, and district administrators like Kimmy and Kai)

Material resources.

Teachers and the principal in Case 1 described the following material resources:

- Time, such as weekly grade-level meetings and some release time from the principal
- Curricular materials (textbooks like Van de Walle (2005), websites, articles, science books, the Common Core State Standards (CCSS) framework
- Some technology (iPads) and manipulatives

Time.

Weekly PLC meetings were made possible by the district hiring roaming physical education teachers who taught all the students in a particular grade-level at one time while the teachers of those students worked together. Additionally, Mia and Principal Ron described some release time that she and others received from her principal with the purpose of this release time unspecified.

Curricular Materials.

All participants reported using textbooks like Van de Walle (2005), or as Jimmy called it the “Project X bible”, to assist in planning instruction. Mia stated that the Van de Walle text, which she first used during her credential program and again during Project X, served as her “go to” when she had a question about mathematics and teaching mathematics to students. Mia also described her principal as supportive of this textbook.

A lot of us used the lens of Van de Walle very, very heavily. Lot of us still, I mean, it's out on our desks. Our principal here supports it very well. And if I'm explaining to someone, or new teachers come in and observe bits of people [sic]. It's, this is where I go.

Principal Ron confirmed this when he said he had “provid[ed] resources like Van de Walle and things like that, you know, to keep the conversation where it should be and needs to be.” A few teachers reported getting materials like sample performances tasks when they attended district-arranged trainings.

Bertha, Ben, and Mia used the internet to find ideas for and ways of thinking about concepts. Ben described that, “You really don't have to create a whole lot on your own,” and cited Engage New York as a useful website and an important resource for finding performance tasks and lessons. Bertha used content from another subject area, like social studies and science books, to help her think about teaching mathematics content. For example, she asked herself, “How can I take what we're learning about the [local valley] and do some kind of math with it?” With support from the state in implementing California’s Core standards aligned with the Common Core State Standards, Jimmy reported new technology like iPads was made available to him.

Principal Ron described material resources that the district gave to him to support teacher collaboration at his site like time, textbooks, and copies of the new CCSS framework. Principal Ron had bought all teachers at his site a copy of the Van de Walle (2005) textbook. He referred to it to answer teachers’ questions about mathematics, student thinking - “content, what's important, you know, sequence of the content or different tasks, or things that they can do with the kids.” This practice was

confirmed by Mia when she described how she referenced Van de Walle with other teachers. He also created a copy of the new CCSS framework that detailed the standards, instructional strategies in particular strategies to use with students who had learning disabilities, assessments, and an appendix with addition and subtraction strategies. He also described encouraging teachers to use the framework to answer their questions. “The trick is to get them [teachers] to use it so it's not just a nice pretty book. But for them to use it. So, you know, if they'll ask questions, ‘Hey, you know, how deep do we need to go with volume?’ And those kinds of things. If it's an email, I'll usually copy paste. ‘This is what the framework says.’”

Principal Ron described modeling what he wanted teachers to do when they have a question, referring to both the Van de Walle text and the CCSS Framework. He wanted teachers to habitually refer to these resources. He believed that teachers using the Framework for instructional guidance was a sign of transformation as stated by the state’s department of education implementation plan.

And if you look at this [State Department of Education] implementation plan, it very clearly says one of the indicators of transformation is that teachers are using the framework for instructional guidance and professional development.

Mia described a lack of resources while her site transitioned to Common Core in spite of references to the material resources of Van de Walle, enhanced CCSS resources, and access to new technology. She mused that the reason she did not have a “concise resource” from her site was due to her site and district’s lack of knowledge of good resources.

And still to this point there's nothing from our sites as much. The Smarter Balanced and different websites and different things like that. But that was all through people in the cohort. So, not because they don't want to. But I don't know if our sites and our district even know what good resources are at this point.

Human resources.

Recall that human resources are qualities of individuals that can be exchanged, oftentimes including understanding student thinking, knowledge of standards, and perspectives from grant experiences like Project X. Participants in Case 1 described the following human resources:

- Attending district trainings about CCSS math standards and performance tasks
- Shared experiences and values from Project X
- Carmen's ability to unpack mathematics
- Carmen's ability to relate "what comes next"
- Ben's knowledge of research
- The principal's knowledge of mathematics that stemmed from teaching middle school mathematics and knowledge of the CCSS
- Kimmy's knowledge of pedagogy and how to navigate district

District Trainings.

Bertha and Carmen described attending conferences and district trainings to learn about the new mathematical standards. Some of these district trainings were facilitated by Kimmy, such as the lesson study trainings for teacher leaders from each grade level at each site. Mia described that being able to participate in the Project X

grant served as a resource: “Being able to participate in the project I guess was getting us resources!”

Principal Ron stated that the district paid for teachers to attend a two-day summer training with an expert on DuFour’s model of professional collaboration. “So the intent was there,” but “the delivery was terrible.” He continued on to say that, “it’s [teacher collaboration] certainly something that’s recognized as valuable by the district office. And their associated funds to support it.”

Principal’s knowledge of mathematics, pedagogy, and the CCSS framework.

Bertha, Carmen, and Jimmy all described their principal’s knowledge as a resource since he provided skill and knowledge. “He’ll come into our PLCs or he’ll see our emails and what we plan on talking about. And if he has a resource on division, he’ll send us websites or links or he’ll give us print-out articles for us to read,” Bertha described. Carmen reported sharing a common passion for mathematics with the principal, who used to teach middle school mathematics. The principal had the skill to teach a math lesson, ask questions, and engage in conversations about mathematics.

My principal is like, he’s really, really good when it comes to math. He was a math teacher, and he has a passion for math. So, more so than ever in my entire thirteen years, have I had a teacher, or principal, who will come in, and will, will teach lessons, and will have those Common Core kinds of questions, conversations and questions and... So he is my resource, like huge.

She also described that he provided access to material resources like manipulatives and textbooks.

And anything that we want related to math, whether it’s manipulatives, or it’s more Van de Walle books, or you know,

other content-related reading, he'll get it for us. If you ask for it, he'll totally find a way to get it for you.

Principal Ron confirmed role described by teachers at his site. Principal Ron knew mathematics content and how to teach the mathematics in part because of his teaching middle school mathematics before moving to his site as principal. Thus, while working with different PLCs, he described that he could ask questions to focus teachers' attention while at the same not being "over bearing." For example, while working with the second grade teachers to write a performance task on regrouping, he used the text to see if and how the framework addressed regrouping.

They start to kind of look at different tasks they could give the kids. And, and I was looking through the standards and said, 'Hey, I don't see re-grouping in here. Does anybody else see it?' And they were looking through, you know. Nobody could find the grouping.

The principal explained to the teachers that students "should be using place value understanding to, you know, add and subtract. Those kinds of things." He also noted to the interviewer the importance of him using the framework so that they teachers do not "get off the ground too far with. Or just transition from what they've always done in the past, or standards/content that's always been, you know, essential or considered essential in the past that doesn't just transfer over to the Common Core Standards." Thus, the principal described himself as a resource through researching standards in the framework with grade-level groups and asking teachers questions to focus their planning for instructional activities. Principal Ron also described serving as a resource by teaching lessons in teachers' classrooms. He described the purpose of teaching in teachers' classrooms to give teachers "a discussion point in their PLCs". In teaching a

lesson, the principal provided a context to discuss pedagogy, the teachers may discuss what the principal did when he taught.

Qualities of teachers.

In addition to the qualities provided by the principal at their site, participant teachers also described qualities and knowledge of other teachers at their site. Bertha cited Carmen’s ability to unpack mathematical ideas as a resource. Bertha reported that conversations with Carmen served as a resource to her as they allowed her to gain a better understanding of new ideas learned during trainings, for instance.

Just going to [district-provided] trainings and they have things about math, or example performance tasks, or example tasks. Those are the resources that, I mean, it's overwhelming for me. You know? It really is. But it's good because then I talk to Carmen about it, and [ask], ‘What do you think?’

Another human resource included Carmen’s ability to relate “what comes next” in instruction. Due to Carmen’s previous fifth-grade teaching assignment at her previous site, she had “that perspective to be able to say, ‘Okay, this is what your kids are coming in with, and this is what the kids need to know.’” Mia also described Ben as a resource for understanding research, relaying important concepts and ideas in the research literature. “‘Marazano says this,’ or ‘this research says that,’” Mia explained about Ben. “Those people will just by definition be, they'll be tapped into other research or projects.” Carmen and Mia also asked questions to Ben.

If we have a question, a lot of times like Ben and I will come back. We'll go back and forth. If he has a question that he thinks I can answer, I will try to find the answer for him, and I'll do the same thing; he'll do the same thing for me. So that's cool.

Jimmy described his fellow non-Project X fourth- and fifth-grade teacher Todd

as useful both in person as a resource as well as when Jimmy searched for other resources online. “He’s popping up [on the internet]. I mean, he does a blog with his brother, an educational blog. He was teacher of the year for the county. So he’s constantly coming up with things.” Jimmy noted that brainstorming with Todd was good because “it challenges us, and makes us think, ‘Oh yeah! Well, let’s, lets do that. Let’s look outside our little realm.’”

District administrator’s knowledge of mathematics pedagogy and standards.

Ben described Kimmy, the co-principal investigator for Project X and TOSA, as a resource for providing answers with regards to mathematics pedagogy and standards. Ben said that when she did not know the answer to his question, Kimmy “knew somebody who can get the answer.” Ben also stated that Kimmy offered to teach a lesson in his classroom. Kimmy was described as a resource that helped teachers navigate the district, like informing Ben of the district’s goals and helping to lead Mia during the district-led lesson study training. Thus, Kimmy provided knowledge about how to navigate the district.

Material and human resources require social resources that are capable of generating these resources. On the other hand, new material and human resources can be generated from social resources, or the relationships among people and groups that attract other resources to those people or groups. I now report results that examine these social resources, or as Gamoran (2003) stated, “communities and catalysts” (p. 72), to see how communities can sustain generative change.

Social resources.

Participants at Case 1 described having the following social resources:

- Shared norms, values, and language among teachers
- A network of colleagues (friends, former Project X teacher, non-Project X teachers, principal, and district administrators like Kimmy and Kai) as resources that supported their teaching

Bertha described conversations that resulted from having a network of colleagues as resources that supported her teaching.

Just talking with different people, too. Like on campus here. I have a question and Carmen's not here, I'll ask Ben or somebody like that. I'll ask Ron or I'll ask Kai about... wish I could ask Kimmy but she's, you know, she's not close by. But other than that, no.

Carmen echoed this when she said described her network of teachers as a social resource that spanned sites and grade-levels whom she could turn to when she had a need or a question.

I think that that's probably the thing that we are most fortunate about here. Even outside of my grade-level. But like with the fifth-grade teachers, and we've all, for the most part, been teaching long enough now. At ten years and longer, that we've established relationships with teachers in other schools and in other districts. And so, when a need, when there's a need or there's a question, we, we all know somebody that we can reach out to that can help us with that.

Jimmy described a network of former Project X teachers that he could ask questions about teaching. “The people from Project X, for the most part, are, they're more eager, more inclined to look for outside stuff, make connections elsewhere. Just see education as a bigger picture.” Jimmy noted, however, a distinction between having connections and making use of those connections. For instance, when asked whether his grade-level group had connections to resources, people, or groups outside

of their group, he replied yes. “I think whether we use them or not is, you know, is another story.” Ben, too, described Project X participants as helpful resources. When asked if there were any other types of resources that his school gave to support he and his colleagues, he replied, “Yeah, I think there's a lot of really good math people in our district that we can go to. And we take advantage of that.” Mia noted that her network consisted of both family friends at universities or district offices, and colleagues who served as connections to other resources.

As mentioned before as a human resource, many of these teachers described the principal as part of their network of colleagues who they turn to for attracting material and/or human resources. Bertha’s connection to her principal served as a resource because of the support that resulted from their professional relationship. Carmen reported a strong professional relationship with her principal, describing him as her “go-to” person when she had a question about teaching mathematics.

He's my go-to I guess, when you asked me like, who do I talk to. He's the person I go to when I have a question about something. And we need to like think through a lesson for me. Or if I get stuck. Cause I still get stuck, and I still go, 'Oh crap! I can't get my way out of this one.' Cause a question will come up, or something. Somebody will be doing something, and I recognize that the lesson is going in a way that I wasn't prepared for. And I still get anxious.

She described her principal as knowing “a lot about math.” She continued to say that, “He knows a lot about how kids learn math. And he believes it starts with questioning.” She said that his way of approaching teaching aligned to hers, which often involved selecting tasks that helped to elicit students’ thinking. “And his whole thing, which is very is, it's in line with kind of like what I think. You know, like, give

them a problem, throw it out there, see what they can do. Which I've always taught that way.”

Ben described people like his principal and Project X participants as helpful resources. When asked if there were any other types of resources that his school gave to support he and his colleagues, he replied,

Yeah, I think there's a lot of really good math people in our district that we can go to. And we take advantage of that. At the district, like I said, the principal he's a good resource. Through the Project X, we met a lot of professors at [the university]. They've been very helpful. And I know that, and I have, I've emailed them a couple of times with questions. That's been nice to be able to have that kind of resource.

Teachers described others as connections that attracted other resources, like Ben describing Kimmy that could point to other resources when she did not know the solution to his questions, and Mia’s connection to Ben that allowed her to ‘tap into research’ and serve as a source of support for their teaching. Mia also described working with TOSA math coach Kai about mathematics. Thus, social resources existed in the form of a network of colleagues who knew mathematics, with many citing Project X participants, the principal, and other district administrators like TOSA Kimmy who served as ties to other resources.

To exemplify Mia’s social network that helped her attract other resources, Mia described learning about Engage NY through her network of colleagues.

This year, and at the end of last, through talking with people in the cohort. Or close friends, rather, not the whole cohort. The Engage NY math program, I found that. And I've been using that. But those are all again not from our sites.

Mia noted that this resource resulted from her social network outside of her site.

Principal Ron described resources for teacher collaboration like a network of teachers, including the role he played as a principal. He noted that collaboration time had to be “driven by teachers” yet at the same time follow what their teacher contracts described for their professional collaboration time.

Summary of Case 1 resources.

In summary, teachers at Case 1 were supported by material resources like time (approximately 50 minutes of weekly PLC meetings and some additional release time), curricular materials (mathematics textbooks like Van de Walle (2005), websites, the CCSS framework, and articles) and technology (iPads) and manipulatives; human resources like district trainings (about CCSS math standards, performance tasks, lesson study, the Project X grant, and DuFour’s model of collaboration), Principal Ron’s knowledge (on mathematics, pedagogy, and the CCSS framework), qualities of teachers (Carmen’s ability to unpack mathematics and relate “what comes next”, Ben’s knowledge of the research literature, and Todd’s brainstorming abilities), and district administration TOSAs like former Project X co-investigator Kimmy; and social resources like shared norms, values, and language among teachers, and a network of teachers (friends, former Project X teachers, non-Project X teachers, principal, and district administrators like Kimmy and Kai). All these resources were reported to support teacher collaboration.

Interestingly, Principal Ron did not describe working with other district administrators or teachers. Other data sources suggest that he is connected to Kai and Ben through engaging in professional development experiences for their district. At the time of the interview, he did not mention working with them. Note that I expand

on each case's social resources during Part II of this chapter.

Case 2 Resources for Collaboration

Anita, Kamille, and Nancy all taught at a middle school in Sun Valley – Anita as a resource specialist program (RSP) teacher, Kamille as a seventh-grade mathematics teacher, and Nancy as a sixth-grade mathematics teacher. One other Project X participant who taught at this site was not interviewed for the study. Table 4-3 summarizes resources described by participants at Case 2.

Table 4-3. Summary of Resources at Case 2 in Sun Valley.

Type of Resource	Resources
material	time for content, departmental, or grade-level teacher meetings, and release time; curricular materials (websites, mathematics methods books, district workbook, assessments, and district website); and some manipulatives
human	district trainings; Principal Kate's knowledge (setting the vision, engaging in four guiding PLC questions, providing knowledge about the new CCSS standards); skill about teaching mathematics from TOSA math coaches
social	network of teachers in department, Principal Kate, and TOSA mathematics coaches

Material resources.

Teachers and the principal in Case 2 described the following material resources:

- time such as late start Mondays meetings for content, departmental, or grade-level teacher meetings, and some release time

- curricular materials including websites, mathematics textbooks like Van de Walle (2005), district workbook, assessments, and district Google Drive website)
- some manipulatives

Time.

All three interviewed teachers reported the material resources of time provided for content groups, departmental groups, and cross-grade groups. Approximately one of the late start Monday meetings a month enabled all teachers in the same department gathered to collaborate, while the other weekly meetings were for teachers to gather who were teaching the same content within a department. Additionally, sometimes teachers met in vertical teams. Kamille also described that she, the teacher that taught the same content as her, and two resource teachers who taught math sometimes used one of their preparation periods per week to work with other colleagues. Principal Kate confirmed what these three teachers reported when she said that the district gave teachers time for professional collaboration during late start Monday meetings - either “job-alike,” meaning teachers who taught the same content, “departmental,” meaning all teachers who taught the same general subject, or grade-level meetings that brought teachers together from different content areas. Principal Kate said that these late start Monday meetings were guided by the four PLC questions: (a) what do we want students to learn, (b) how will we know that they have learned it, (c) what will be do if they do not learn it, and (d) what will we do if they do learn it?

Each teacher had one preparation period per day for instructional activities, but not necessarily to collaborate with others. Kamille described that since they lacked the material resources she would have liked to have for teacher collaboration, she often worked with teachers unpaid after school or on the weekend since “it’s just sometimes it’s not conducive [to use our prep]. We don’t have the time.” This served as a response to a lack of material resources such as paid time for teacher collaboration.

Anita stated that Principal Kate offered teachers release time to observe other teachers. Principal Kate confirmed that she supported groups with release time a number of times a year to model and “set up a structured setting where they’re collaborating together”. These release days were different from observations. Principal Kate explained the purpose of this as having “that success and they know what that looks like” for when they try it in their PLC. For instance, Principal Kate described using a release day to help guide teachers to learn how to analyze a unit planning organizer and to have “positive experiences” with better understanding a particular standard. Release time was given to teachers by both the discretion of Principal Kate and the district.

Curricular materials.

These teachers reported using curricular materials like the internet, textbooks like the Van de Walle (2005) textbook, and CCSS aligned assessments to support their collaboration. Anita and her grade-level colleagues used *TeachersPayTeachers* to find material resources so that they can create lessons and units without the use of a curriculum. Kamille described a district workbook and internet sites as resources that supported her grade-level math collaboration. Nancy thought that her textbook was not

useful since they “just tell the kids to do this to this.” She felt that the textbook did not give explanations on why students do what they do, and thereby hindered students in developing a deep understanding and fluency of a concept. She noted the Van de Walle (2005) textbook from Project X served as a way to get ideas for lessons. Anita reported material resources like assessments that help them to plan lessons. “They gave us our assessments, and they tell us to find the rest.”

Another material resource reported by teachers included a district Google Drive website that housed materials for teaching. These materials, like unit planning organizers, unit and final assessments, and links to other resources, were vetted by the mathematics coaches. Principal Kate stated that this online repository was particularly important because of a lack of curriculum for teachers to use.

Manipulatives.

Nancy noted that they had few manipulatives - a textbook came with manipulatives but only enough for the instructor to model with them and not enough for students to use. No other teacher mentioned them.

In sum, teachers at this site described access to a number of material resources, including time through late-start meetings, time via preparation periods, and time through release day given by the principal and district; curricular materials like the Van de Walle (2005) textbook, the Google Drive maintained by district TOSA math coaches, and online resources like *TeachersPayTeachers*; and some manipulatives. Still, each teacher reported inadequacies to their access of materials resources and recognized that material resources were not widely available during the current school year. Anita reported that the district provided “nothing” and “very little” resources for

the Common Core Standards, describing her situation as one where she and her colleagues were “trying to stay above water”. She continued on to say, “sorry, it’s the truth.” Kamille’s curt initial response to a question about resources – “They’ve given us a ton of internet sites. We have the district workbook. Yeah.” – suggested limited access to material resources. Nancy described few material resources that supported her teaching of sixth grade math. “There’s no resources. It’s awful.” All teachers indicated a lack of material support for teaching the Common Core Standards.

I now describe the human resources reported in Case 2.

Human resources.

Human resources at Case 2 included:

- district trainings
- principal (setting the vision, engaging in four guiding PLC questions, providing knowledge about the new CCSS standards)
- TOSA math coaches Curt, Moe, and Dianna (planning, teaching, and debriefing math lessons with teachers)

District trainings.

Anita cited attending district trainings that the school district provided for teachers. Principal Kate also discussed teachers’ involvement in district trainings. She explained that the district had recently invested in human resources by training teacher leaders. “What our district has done is it has taken over the last couple of years some teacher leaders, some really awesome effective educators, and presented them with the new standards [and] presented and trained them on what are the shifts in instruction.”

Principal Kate said that groups of teacher leaders from each grade-level at her site and across the district were given time to collaborate and take apart standards to group them according to units. By looking at examples of assessment items and other resources, teachers identified priority and supporting standards to create big ideas and essential questions for all teachers in the district. After this, these teacher leaders developed end-of-unit assessments that were used district wide.

Principal Kate's vision setting.

Principal Kate noted that she played a minimal role during PLC time, since they are “teacher driven”, by setting the expectation and “the vision” with what does it look like to engage in the four guiding PLC questions and also providing knowledge about the new CCSS standards. “My role I guess would be more, you know, it’s setting the vision, it’s teaching how we work together. It’s introducing new standards, it’s introducing the shifts.” She described supporting the PLCs by asking them what she could help them with. “I’ll walk around and ask the various teams, do you need anything? What can I help you with?” She made sure to guide the conversation back to the four guiding PLC questions when conversations shifted to talking about field trips, for instance. None of the teachers reported the role of vision setting that their principal played.

Mathematics coaches.

This site was also supported by mathematics coaches working with teachers on specific aspects of mathematics instruction. Kamille reported that TOSA math

coaches Curt and Moe⁷ modeled practices of an exemplary mathematics teacher and facilitator of student thinking when they planned, taught, and debriefed mathematics lessons together. Nancy also noted that TOSA math coach Dianna⁸ often helped her grow in her ability to question students' mathematical thinking. "Whenever Dianna gave an example [...] I'm writing the questioning style down because it doesn't come naturally to me."

Social resources.

Teachers described having connections to teachers in their department, the principal, and TOSA mathematics coaches like Curt, Moe, and Dianna. Kamille described planning, teaching, and debriefing mathematics lessons with both coaches Curt and Moe, with a focus on what students analyzing, justifying, and clarifying misconceptions about the objective of the lesson. Nancy reported that Dianna helped teachers in her group gain access to material resources like manipulatives. "Dianna's our link. We'll tell Dianna, 'We need this,' and Dianna will deliver it to the site. And then those things get lost, so we don't know where they are at." Nancy's relationship to Dianna also provided human resources like the support to help Nancy understand how to enact mathematics pedagogy of questioning students. One way that TOSA math coach Dianna served as a resource to teachers like Nancy was through facilitation of teachers coming to understand the knowledge rather than being told it directly. Nancy described Dianna as,

⁷ Both Curt and Moe served as mathematics coaches during Project X for teams of high school algebra teachers.

⁸ Dianna served as a mathematics coach during Project X for middle school mathematics teachers.

Really good about not telling us stuff, but allowing us to kind of come to realizations [...] But she was just really good about... Cause some of the coaches just couldn't release their, you know, need to control. And Dianna was very good. I felt like if we got off track, she was able to very carefully pull us back on track. Like she was always telling us, 'You guys are way better.' But we were way better at planning the lesson because of her leadership type of abilities.

Teachers at this site did not describe former Project X teachers as part of their network, including former Project X teachers currently at their site teaching at other grade levels⁹. This is interesting to note due to the presence of cross-grade-level collaboration meeting times that occurred once a month.

Summary of Case 2 resources.

Teachers at Case 2 in Sun Valley school district described material resources like time (late start Monday meetings for content, departmental, or grade-level meetings, and release time), curricular materials (websites like *TeachersPayTeachers*, mathematics textbooks like Van de Walle (2005), a district workbook, assessments created by teacher-led groups at the district office, and a district Google Drive website repository of materials as crafted by the TOSA mathematics coaches organized by content), and some manipulatives; human resources like district trainings, Principal Kate's knowledge (on setting the vision, guiding PLC meetings, and providing knowledge about the new CCSS standards), and the skill about teaching mathematics from TOSA math coaches (Curt, Moe, and Dianna); and social resources like a

⁹ One of these other teachers, six-grade teacher and former mathematics coach from Project X named Dan, participated in the online survey for this study but not the interview. On this survey, he stated that he continued with lesson study but had not completed a full cycle. He also stated that he met with teachers after school to engage in lesson study since although his school provided collaboration time, it was not geared towards lesson study. I followed up with him multiple times because he agreed to do an interview. Yet he and I were not able to find a time that worked with both of our schedules.

network (including teachers who taught similar content, Principal Kate, and TOSA mathematics coaches). All these resources were reported to support teacher collaboration.

Case 3 Resources for Collaboration

Tonya is a seventh-grade teacher in Long Pond school district and was the only teacher at her site interviewed from Project X. Three other Project X participants at her site were not interviewed for this study – two at the eighth-grade and one sixth-grade teacher. Though her district hired roaming physical education teachers for elementary school teachers, middle school teachers did not have PLC at her site this year due to budget constraints. The district did offer to pay teachers 3 hours a year for collaboration time outside of regular school hours.

Table 4-4 summarizes the resources for the participant at Case 3. I now give evidence to support these claims.

Table 4-4. Summary of resources of Case 3 in Long Pond.

Type of Resource	Described by Participants
material	time (pay teachers 3 hours for collaboration, release time), some curricular materials from the eighth-grade
human	district-led lesson study training
social	few connections

Material resources.

Tonya's district had recently discontinued PLC time due to district funding issues related to reduced bus schedules for students due to staffing cuts. Consequently, she did not have contracted paid time for collaboration with other teachers. Although

the school managed to align her preparation period with other teachers, she described that the majority of this time was spent planning individual educational plans for students and meeting with parents. Tonya stated that the district gave each teacher three hours to use however they wanted to that year. She stated that her principal also had funds to allow each teacher one whole day with their other mathematics teachers. At the time of the interview, she had not used these material resources.

Tonya did not mention many curricular materials, in part because she described creating lessons on her own due to the district's lack of a new curriculum aligned to the Common Core Standards. Tonya did use some of the eighth-grade teachers' curricular materials to help her plan for one of her accelerated courses. Tonya noted that beyond these material resources of 3 hours of collaboration time and a release day and "beyond what you're already busting your butt to do, it's on your own dime."

Human resources.

Tonya described engaging in a lesson study at the beginning of the school year in a "train the trainer" workshop on lesson study. She described working with "very brilliant teachers who were also good at mathematics," who served as a human resource to Tonya. These teachers not only understood mathematics like Tonya did, but they were in Tonya's eyes good at using pedagogy for enacting successful lessons. To explain, Tonya compared her skills as a mathematics teacher to these "brilliant" teachers using an analogy. In the analogy, she was a NBA basketball player and the "brilliant" teachers were Michael Jordans.

I'm not Michael Jordan. I'm definitely I'm an NBA team [player], but I'm not that star. You know, I'm good at what I do, so obviously I'm a pro. But you know, there's those shining stars that they're naturals. And I think that when you get some of those naturals to come in to the discussion, it helps teachers like myself who would never normally think about that. You know, Michael Jordan can tell you all day long how he practices and what he does, but at the end of the day there's just some magic about him, right? There's, I worked with some magical teachers the other day. And they were, they were very like, creative in their thinking. And like I was like writing everything down. "Let me see your book". You know? "Could I look at your lesson organizer?" You know? So I think that's the positive of it, when you can get teachers that are really good, like. I'm a good teacher, so don't, I'm not bashing myself. But there's people that are extraordinary teachers. When those teachers can meet with good teachers, good teachers like me can use their lessons and be great teachers for the kids' sake.

Tonya did not report the principal to be a resource that supported teacher collaboration, unlike those participants in cases 1 and 2. Additionally, she did not report the support of any qualities or knowledge provided by TOSA math coaches.

Social resources.

As will be further elaborated using the sustainability framework, Tonya did not describe many relationships to other teachers. She described feeling "isolated" and "an island unto myself." Tonya described that she did not collaborate with the one other seventh-grade mathematics teacher at her site about instruction and only sometimes asked eighth-grade teachers for resources on eighth-grade mathematics. The eighth-grade teachers helped Tonya to teach one of her courses that compressed both seventh- and eighth-grade mathematics into one school year.

Summary of Case 3 resources.

Overall, Tonya described fewer resources for teacher collaboration compared to Cases 1 and 2. For material resources, Tonya stated that the district gave teachers a one-time three paid hours for collaboration to be used at the teachers' discretion. The principal also could give her one day of release time. She did not report using either of these resources at the time of data collection. Tonya sometimes shared curricular materials with eighth-grade teachers to help plan for an accelerated seventh-grade course. For human resources, Tonya described attending the district-led lesson study workshop geared to train trainer teachers of lesson study with other "brilliant" teachers from around the district. For social resources, Tonya did not describe many relationships to other teachers except to 8th grade teachers to attract mathematics curricular materials to aid Tonya in planning on her own. Unlike Cases 1 and 2, Tonya did not report the principal to be a resource that supported teacher collaboration. Additionally, she did not report the support of any qualities or knowledge provided by TOSA math coaches. As she described, "I'm an island unto myself."

Case 4 Resources for Collaboration

Case 4 involves all Project X teachers interviewed for this study at one elementary school site in Sun Valley school district. Kerry and Don were two of the three fifth-grade teachers, and Ceci was one of the four third-grade teachers at this site. Table 4-5 summarizes the resources at Case 4 in Sun Valley.

Material resources.

Material resources reported at this site included:

- time (weekly PLC time, biweekly collaboration for Common Core related activities, release time for lesson study)
- curricular materials (websites like *Ed Helper* and *TeachersPayTeachers*, textbooks aligned to Common Core mathematics, Google Drive website, and end-of-unit assessments)
- technology (laptop & mimeo set) and manipulatives

Table 4-5. Summary of resources at Case 4 in Sun Valley.

Type of Resource	Described by Participants
material	time (weekly PLC time, Common Core biweekly time, release time for lesson study), curricular materials (textbooks, district Google Drive website, and others <i>Ed Helper</i> and <i>TeachersPayTeachers</i> , end-of-unit assessments, pacing guide), technology (laptop, mimeo set, SmartBoard) and manipulatives
human	shared values, norms, and language; Kerry representing grade-level in district-wide PLC
social	network (own grade-level)

Collaboration time for fifth grade teachers included weekly Wednesday PLCs per teacher contracts, new biweekly Tuesday PLCs supported by the district hiring a Visual Arts Performing Arts (VAPA) instructor who taught grade-level students for approximately 50 minutes per week, and biweekly Tuesday staff meetings. Kerry and Ceci noted that funding for the extra PLC every other Tuesday during the current school year came from the district hiring the VAPA teacher. “They’ve given us time, and I appreciate that,” Kerry said about her collaboration time. Don described that teachers determined the agenda in this PLC time, a departure from in past years. He noted that he and his colleagues were “taking more charge of it because we have to do

all the work” as compared to last year when they did not determine the agenda. He continued, “We’re saying, ‘This is what we’re going to use our time for.’” Their principal confirmed this by stating that teachers set their own agenda for collaborative meetings. Don, Kerry, and Ceci also described the district paying for time wherein each grade level team chose to spend this time engaging in a lesson study. This paid time included three half-day substitute teachers to cover each of the teachers’ classroom for the enactment and debriefing aspects of lesson study. Ceci noted about having half-day substitute teachers for their mini-lesson study that “we’ve never had that before.”

Curricular materials.

Curricular materials like textbooks included a mathematics textbook aligned with Common Core that gave examples of content standards. They also accessed Internet sites like CommonCoreWorksheet.com and other states’ Common Core websites to plan lessons aligned to Common Core Standards, and even purchased with their own money materials from *EdHelper* or *TeachersPayTeachers*. The Google Drive website housed lessons and other teaching materials. Kerry and Ceci both stated that the district provided them with unit assessments and summative assessments designed by a team of teachers. Teachers then used these to design lessons. Kerry stated that, “We sit down with the standards, we look at the examples that our standards provide us with, and then we determine what needs to be done in order to thoroughly cover those standards in the time provided.” Ceci stated, “They [at the district] are allowing a cohort group of teachers from each grade level across the district create the assessments. Which then kind of guide our instruction.”

Technology and manipulatives.

Technology included a laptop from the district and a mimeo set that served as an interactive screen that one could project onto by using particular programs. Ceci and Kerry described receiving some materials from the adoption of GoMath! Curriculum. Kerry noted that they were difficult to incorporate due to a delay in their arrival to her site. Kerry noted that she collected mathematics manipulatives over the years as teachers leave their materials, like unifix cubes, wooden blocks, and base ten models.

Both Don and Kerry noted a lack of resources in that the district did not know whether they would have money to pay for consultants and others to gather information that might be useful for teachers. “So then you’re, they’re then relying on the teacher to come up with everything and all the resources.”

Human resources.

Don and Kerry described that they each served as a resource to others at their school, including both teachers and the principal. Principal Paula noted that they served as resources to other teachers at their site due in part to their experiences with grants like Project X and familiarity with the new standards. Don stated that teachers in his grade-level were even able to help the principal understand lesson study better. Kerry represented her grade-level in attendance at a district-wide leadership PLC where teachers representing every grade-level at each site and their principals met to learn about implications of the Common Core Standards. Don, Kerry, and Ceci did not describe working with a mathematics coach or their principal other than to coordinate and check in with her on their activities.

Social resources.

The fifth-grade teachers shared values, norms, and language on teaching, and described trust among each other. One way they demonstrated trust was that each fifth-grade teacher felt comfortable teaching in front of the other during a recent enactment of a lesson study. A sense of shared values on professional inquiry and effective teaching among each other will be further elaborated in Part II. Both Don and Kerry described working closely with each other and the other fifth-grade teacher, who had experience in a different lesson study grant prior to Project X. Don described that this served as a resource for his group. “We’re coming up with our own models to use so the kids can know every part of the problem... so a lot of the resource is us. We are better people because of all this.”

Don and Kerry described a lack of connections to many other people. Don expressed that he would like to but did not have the time to do so. Don stated that he could understand why teachers were going out on medical issues “due to the stress of trying to write a complete curriculum compared to have it ready made with all the books.” He described “having to do everything from scratch” without having enough time to do it. Kerry stated that although she might see an Project X teacher from another site at the district-PLC, it was only to say hello, “not to be able to share resources.” She continued to express a limited access to teachers in her network when she said, “I miss the Long Pond teachers, I really miss them. But I know they're probably as buried as I am with Common Core implementation. And now I know why the math grant ended when it did.”

Ceci did not name working with other teachers except her grade-level teachers. She discussed mathematics with one of her fellow grade-level teachers¹⁰ over lunch and sometimes during formal grade-level meetings with the other two third-grade non-Project X teachers. When asked if her group had connections to resources and people outside of their group, Ceci said no although she sometimes met with Project X teachers to say hello. “Outside the school, we've informally gotten together and just, you know, had social hour because we miss each other. But not really working together.”

Summary of Case 4 resources.

For material resources, Don, Kerry, and Ceci described grade-level group collaboration time (weekly PLCs described in their contracts, biweekly additional Common Core PLCs paid for by VAPA teachers, biweekly staff meetings, and additional release time for one round of lesson study in the form of three half-day substitute teachers); curricular materials (textbooks, district Google Drive website, websites like *TeachersPayTeachers*, and assessments and pacing guides created by teacher leaders and supported by the district); technology (like a laptop and a mimeo set) and manipulatives. For human resources, Kerry and Don both described shared values, norms, and language. Kerry brought knowledge about implications of the Common Core to their grade-level group from participating in a district-wide PLC, and both helped make other teachers at their site knowledgeable about the new standards. For social resources, both Don and Kerry described working closely with their grade-level group, with shared values on professional inquiry and effective

¹⁰ This teacher did not participate in the current study.

teaching. Additionally, their relationships to teachers at their site provided others human resources for information about the Common Core Standards; this was confirmed by Principal Paula. All resources were reported for teacher collaboration

Summary of Resources Across All Four Cases

Gamoran (2003) referred to three types of resources that help to support mathematics and science teachers engaged in teaching for understanding: material resources, or time and curricular materials, human resources, or access to knowledge from outside and inside schools, and social resources, like communities and catalysts. Access to these resources for teacher collaboration varied across each of the four cases. See Table 4-6 for a complete breakdown of resources across each of the four cases. Cases 1 and 4 involved elementary school sites and Cases 2 and 3 involved middle schools.

Table 4-6. Resources supporting teacher collaboration across four cases.

		Case 1	Case 2	Case 3	Case 4
Material Resources	time	weekly 50 minutes grade-level meetings and release time from principal	late start Mondays meeting for content, departmental, or grade-level teacher meetings, and release time	pay teachers 3 hours for collaboration, release time	weekly PLC time, Common Core biweekly time, release time for lesson study
	curricular materials	mathematics books like Van de Walle (2005), websites, the CCSS framework, and articles	websites, mathematics textbooks like Van de Walle (2005), district workbook, assessments, and district Google Drive website	some curricular materials on eighth-grade mathematics	textbooks, district Google Drive website, and others <i>Ed Helper</i> and <i>TeachersPayTeachers</i> , end-of-unit assessments, pacing guide
	technology	iPads			laptop, mimeo set,
	manipulative	some manipulatives	some manipulatives	some manipulatives	some manipulatives

Table 4-6. Resources supporting teacher collaboration across four cases.

		Case 1	Case 2	Case 3	Case 4
	s				(from adopted textbook)
Human resources	trainings	district trainings about CCSS math standards, performance tasks, lesson study, and grants (Project X)	district trainings	district-led lesson study training	
	principal	Principal Ron's knowledge about mathematics, pedagogy, and the CCSS framework;	Principal Kate's knowledge (setting the vision, engaging in four guiding PLC questions, providing knowledge about the new CCSS standards);		
	TOSA S	Kimmy's knowledge of pedagogy and how to navigate the district	skill about teaching mathematics from mathematics coaches (Curt, Moe, and Dianna)		
	qualities of teachers	Carmen's ability to unpack mathematics and relate "what comes next", Ben's knowledge of research, Todd for brainstorming ideas			
Social resources	shared values, norms, expectations	shared values, norms, and language			shared values, norms, and language
	network	networks (friends, former Project X teachers, non-Project X teachers, principal, and district administrators	network of teachers in department, Principal Kate, and TOSA mathematics coaches		own grade-level, Kerry representing grade-level in district-wide PLC

Table 4-6. Resources supporting teacher collaboration across four cases.

		Case 1	Case 2	Case 3	Case 4
		like Kimmy and Kai)			
	limited connections			few connections	

Material resources: “Time and curricular materials.”

For material resources that supported teacher collaboration, all cases except Case 3 described 50 minutes of weekly PLC time, with Case 4 describing an additional 50 minutes every other week for better understanding the Common Core Standards. Case 2 noted having a late-start Monday that provided time for meetings, including content, departmental, and grade-level meetings. All cases described using curricular materials like websites to find relevant curricular materials, with Cases 2 and 4 describing access to a district Google Drive maintained and updated with curricular materials by math coaches. All cases but Case 3 described accessing mathematics textbooks like Van de Walle (2005) and access to manipulatives, whether it was from their own school site like in Case 1, collecting it from colleagues like Kerry from case 4, or as part of a curriculum like Nancy at Case 2 described.

Teachers in Cases 2 and 4, who were part of the Sun Valley school district, were given materials assembled by teacher leaders as part of a district-led effort to understand the Common Core Standards, like district workbooks, end-of-unit assessments, or pacing guides. These materials were among some of the materials on the Google Drive.

Human resources: “Access from outside and inside the schools”.

For human resources that supported teacher collaboration, teachers across all cases described attending district trainings for the purpose of better understanding a facet to the Common Core Standards. Long Pond Cases 1 and 3 described engaging in trainings geared towards using lesson study to understand the new standards in a cross-site lesson study with one teacher from every grade-level in the district. Teachers at Case 1 and 2 described their principal to be a human resource that provided knowledge and skills about the Common Core Standards and mathematics in the case of Case 1, with the teacher in case 3 not mentioning her principal providing skills or knowledge, and the teachers in Case 4 describing their principal as supportive overall without stating that she gave them particular skills. Teachers at Case 1 and 2, with each case centered in a different district, also both described interacting with TOSA mathematics coaches to learn more about mathematics, with teachers at Cases 3 and 4 not reporting working with TOSAs. Cases 1 and 4 discussed fellow colleagues as providing particular qualities, like knowledge about mathematics or sequencing topics, with participants at Case 2 and 3 not reporting many colleagues as providing human resources.

Social resources: “Communities and catalysts”.

For social resources that supported teacher collaboration, participants reported a range of communities and catalysts. Case 1 participants reported many connections to teachers within their grade-level, some Project X participants and some not, and also across grade-levels, like those who participated in Project X. Some even mentioned that they could reach out to other teachers at different sites if needed.

Participants in Cases 1 and 2 both reported having connections to TOSA mathematics coaches and using them to answer questions, like teachers at Case 1 who reported collaborating with Kai and Kimmy, or to co-plan and co-teach together, as was the case with Kamille at Case 2. Teachers at Case 1 also described their relationship to their Principal as being a human resource for many of their activities, like observing classrooms, supporting collaboration time, and attracting material like articles and human resources like knowledge and skill about the Common Core Standards. Teachers at Case 2 discussed their principal as a resource but less about mathematics and more for setting the vision, guiding PLCs, and providing details about the Common Core Standards.

Expanding on this range of social resources – the many links to teachers, the principal, math coaches, and district administrators like Kimmy as was the case in Case 1, the very few relationships described by Tonya in Case 3 – is what I do in the following section in this chapter. To do so, I use three aspects of social resources from Gamoran and colleagues' (2003) framework for sustainability to examine these four cases in greater depth – *integration*, or shared values, norms, and expectations of participants in a group, *linkage*, or connections to people, resources, or other groups outside of a group, and *synergy*, or the alignment of a group's goals to the greater context that the group is situated within. Doing so will elicit similarities and differences about factors that support and hinder teachers' continuing to engage in lesson study.

In Chapter 6, I continue to elaborate on these resources by examining what practices were reported to have sustained from lesson study. In Chapter 7 I report on

teachers' conceptions of lesson study and teachers' reports on factors that would support and hinder lesson study.

Chapter 5: Results on Integration, Linkage, and Synergy

In Chapter 4, I detailed the range of reported resources that supported participant's collaborations. In particular, I detailed social resources. I now expand on these social resources by reporting results from using a modified version of Gamoran and colleagues' (2003) sustainability framework. These results, along with results from Chapter 6 and Chapter 7, will answer research question (1) on factors that supported and constrained teachers' ability to continue lesson study.

To use this framework, the unit of analysis is a group of participants. Thus, I first look at whom participants reported formal and informal collaboration, and describe the degree to which they share values, mutual expectations, levels of trust, and norms, in other words, levels of *integration*. From these conjectured groups I describe the groups' ability to attract resources through relationships, or levels of *linkage*. As part of my methods, I continued to update my conjectured groups by reanalyzing levels of integration and linkage.

Gamoran and colleagues' (2003) framework also asked the researcher to take a step back and examine the institutional setting within which each group sits to examine the alignment of efforts between a group and the larger context, in other words, levels of *synergy*. Thus, I then examined the degree to which groups saw their goals aligning with the goals of larger institutions, like site or district.

I now report results from the sustainability framework on integration (shared values, mutual expectations, levels of trust, and norms), linkage (social relations that attract resources), and synergy (alignment of efforts of teacher community with those of the larger community) (see Table 5-1) by case. With each case, I first present results

about integration, which determined in part conjectured informal and formal groups, then present results on linkage that reflexively informed these conjectured groups, and finally synergy.

Table 5-1. Conditions for sustainability framework.

Conditions for Sustainability Framework	Definition
integration	“trust, mutual expectations, shared values, and potential for establishing norms” in community
linkage	social relations that attract resources
synergy	alignment of efforts of teacher community with those of larger community

I first state each of the groups that I determined through my analysis, and then support these claims by using the analytical framework of integration, linkage, and synergy. Note that although participants often referred to their grade level group as their PLC, which stood for “Professional Learning Community,” for the purpose of this study I use “PLC” for those groups that met the requirements of a PLC as described in the literature in Chapter 2. These five criteria included shared beliefs and understandings, interaction and participation, interdependence, concern for individual and minority views, and meaningful relationships.

Groups included two formally arranged grade level groups (GLGs) – fourth GLG and fifth GLG - and two informally arranged professional learning communities (PLCs) – fourth PLC and PA PLC. The fourth GLG consisted of two Project X teachers interviewed for this study, Bertha and Carmen, and two other teachers not interviewed for this study, with one of these teachers an Project X teacher. The fourth

PLC consisted of Bertha and Carmen. The fifth GLG consisted of three Project X teachers interviewed for this study, Jimmy, Ben, and Mia, and two non-Project X teachers both not interviewed for this study. The PA PLC included Bertha, Carmen, Jimmy, Ben and Mia, who comprise five of the six Project X teachers at this site, and all of the Project X teachers interviewed for this study at this site. See Table 5-2 for groups and members.

Table 5-2. Groups and their members at Case 1.

Group	Members
fourth GLG	Bertha, Carmen, teacher 1*, teacher 2**
fourth PLC	Bertha & Carmen
fifth GLG	Jimmy, Ben, Mia, teacher 3**, teacher 4**
PA PLC	Bertha, Carmen, Jimmy, Ben, and Mia

*Note: * indicates Project X teacher not interviewed for study, and ** indicates non-Project X teacher not interviewed for study*

Case 1

Integration

I now report on themes within integration of each of the four groups. See Table 5-3 for levels of integration, linkage, and synergy for each of the four groups.

Table 5-3. Integration, linkage, and synergy results for Case 1.

Group	Integration Levels	Linkage Levels	Synergy Levels
fourth GLG	low	low	low
fourth PLC	high	high	moderate
fifth GLG	moderate	high	low
PA PLC	high	high	moderate

Integration of fourth GLG.

The formally arranged fourth GLG was compelled to work together as a result of administration regulation. The culture arose from compulsion and was one of contrived congeniality rather than collaboration (Hargraves, 1994). Recall that the four teachers teaching fourth-grade at this site included three former Project X teachers, only two of whom were interviewed for this study, and one non-Project X teacher. Both Carmen and Bertha started working at the current site within the previous three years. They both taught at the same former site. Carmen served as a mathematics coach for a lesson study group during Project X.

I found three themes pertaining to the integration of the fourth GLG that suggest overall low levels of integration. First, reported views of professional inquiry on mathematics teaching and learning varied among members. Second, reported views of effective teaching varied among members. Third, the group lacked agreement on how to spend their time together (See Table 5-4). In what follows, I elaborate each of these claims.

Table 5-4. Integration themes for fourth GLG.

Theme	Details
Varying Visions of Professional Inquiry	desire to improve their own mathematics teaching and learning
Varying Visions of Effective Teaching	good teaching not mastery of skill willingness to learn similar goals but different paths
Misalignment on How To Spend Collaboration	desire to use PLC time to inquiry into improving practice

Varying visions of professional inquiry.

Carmen and Bertha described a difference in desire to improve their own teaching and learning. They both described that their goals for professional inquiry differed from the other two group members centered. Bertha described a sense of frustration about not having a collaborative group at her grade level because she knew there was more for her to learn about teaching.

I just feel like I always need to be learning. I want to like... Every year I want to outdo what I did the year before, or improve on it. Or think of it in a different way. Because I know it's not like, 'Well, that's it. That's all there is to it.' There's always something.

Carmen also described a goal of wanting to grow as a teacher yet faced challenges in doing so without the support of other teachers and educators.

And a lot of times, people come in and they'll say, 'Oh, no no. You're totally doing it. You're fine!' And I'm like, 'Really? What am I fine about? Give me specifics. I need to know specifically because I can't be fine in everything.' And I need to grow. And I kind of feel like I'm not growing. Other people might be growing, but I'm not growing. I'm not getting that, what I need, from teachers.

Carmen also stated that she wished teachers were motivated at her school like teachers employed year-to-year at charter schools because she felt that a year-to-year contract would motivate teachers to work together to improve their practice. Both Bertha and Carmen described working late after school and on the weekends to improve their practice. This stood in contrast to the other group members, described by Bertha as “when they’re done, they’re done.” Thus, the goal to learn more with other teachers is shared between Bertha and Carmen but not the other GLG members.

Bertha and Carmen described attending as many district trainings, such as

Common Core trainings, as they could and to "always strive to be better every year" as Bertha said. Carmen stated that she and Bertha "signed up for everything we could get our hands on," such as how to align or change their teaching to "anything related to Common Core" to "make everything link for our kids." Yet other colleagues described their attendance to conferences as unfair. Carmen outlined the argument as following:

And then three quarters of the way through the year, other teachers started complaining. 'There's no money available because you took it all.' And it's like, that money was available for all of us. You didn't take it. And then the argument was, 'We didn't know about it.' And we're like, 'We were all told at the same staff meeting back in October that there was money available.' And then the argument was, 'You can't expect us to remember that far back.' And it's like, wait a minute. So now I'm being penalized? You're mad at me because I went to staff development because the district wasn't offering me any? So I had to go seek it out myself?

Bertha and Carmen described different methods for reaching goals with respect to the other two GLG members. Bertha stated that although the core of her GLG's goals was similar, the ways in which each person improved as a teacher differed across GLG members.

At the core, I think that they, we all have the same goals. Just like how we go about it, how we want to improve, it's just that's the difference. Do you want to stay where you are, or do you want to get better every year?

Thus, though teachers might have similar goals, Bertha noted that the paths one takes to work towards those goals differed. The lack of alignment surrounding teachers seeking professional development left Carmen feeling "like I'm teaching right now in a bubble or in a vacuum."

Finally, both Bertha and Carmen explained that the other two teachers thought

Carmen and Bertha were intense in their grade-level collaborations with “personalities kind of clash[ing]”. Carmen agreed that she and Bertha were intense: “I am intense. I know she’s [Bertha] intense. I do take my job seriously.” Bertha described how her colleagues responded that Bertha had dictator-like qualities when Bertha tried to achieve her goal of constantly improving.

My goal's always to strive to be better every year. And I think that my team, sometimes they. They've told me. 'You'd be a dictator if you were my boss. You always want to like read this and read that. And let's plan and let's talk about this and let's look on the internet.' And they're kind of just like, 'Okay, this is what I've been doing for a million years.' And, you know, 'It works, and I get to go and leave early and that's it. That's what I'm doing. And you guys are too intense. You guys are, you know, over-the-top. And we don't have time to read professional articles. I don't have time to look on the internet.'

These examples serve as further evidence that the professional goals of Bertha and Carmen did not align to their GLG’s goals.

In summary, Carmen and Bertha described a desire to continue their professional learning, often through the norms of attending district workshops and through discussing issues of teaching and learning mathematics with others. This goal was not always shared as evidenced by their GLG members lack of desire to engage in the activities of discussing mathematics, reading articles, and researching on the internet as Bertha described wanting to do. Both Carmen and Bertha described a difference in ways of reaching goals among them and the other two members of the group. Though they might share similar overarching goals of wanting students to learn, “how we go about it, how we want to improve, it's just that's the difference.”

Additionally, both Carmen and Bertha described their GLG members' view of themselves as "intense".

Together, these data suggest a lack of shared values on professional inquiry and a lack of norms or ways to engage in activities of professional development among members of their GLG.

Varying visions of effective teaching.

Two types of views on effective teaching existed in the fourth GLG. Some views teaching as traditional and driven by students mastering skill sets, whereas others viewed teaching as conceptual awareness with students continually reflecting on the learning process and making connections by analyzing patterns.

Amongst the fourth-grade teachers, no. We don't have common goals on what effective teaching is. Cause you have two teachers who are very traditional, in like everything is driven by skill. 'I teach this skill. They master skill. I move onto the next skill.' And then you have Bertha and I who are teaching for conceptual understanding, cognitive, cognition, you know, just being aware. Like, what are you thinking? Metacognition, you know. How does what we're learning here relate to what we're learning over here? Analyzing for themes and trends and patterns.

This lack of alignment of pedagogical approaches towards effective instruction created an uncomfortable feeling for Carmen while working with her grade-level group.

Bertha also echoed the notion of different pedagogical approaches towards effective instruction. Bertha stated that the other teachers in her grade-level "have done things in a certain way for a long time. And it's hard for them to see it in a different way."

This stood in contrast to Carmen and Bertha's method of teaching.

Both Carmen and Bertha's views on effective teaching described a student-

centered focus and willingness to deviate from pacing guides based on the interests of students. Carmen's description of effective teaching for students involved "getting kids to process and interpret information, and draw conclusions for themselves" and realizing that "there are many right ways to arrive at the right answer".

Kids are not gonna remember what they learned in fourth-grade when they're 21 or 22. But I do care that they're able to, to like critically think and analyze and interpret and evaluate information. Because, they're gonna be. Like, we're in an age where information is just being dumped upon us. And it's coming at us so fast that we've got to be able to evaluate it, and to, you know, disseminate between crap and between the stuff that's really important and really good. And then we've got to form opinions and ideas about it. And the only way that's gonna happen is if kids are engaged and they start thinking and you ask them to think. So it's just, it's a different way. It's tot-, two totally different ways of thinking about teaching. And yeah, our values are different.

Bertha showed evidence of autonomy in deviating from the pacing guide based on what was best for students. Bertha described that it was more important to go "wherever the kids take us." This contrasted one of the other two members who planned according to a pacing guide.

If the kids are not ready to be there, then how can you be [there]? And so it, and then it starts to fall apart. Because we present lessons, and wherever the kids take us, you know? I mean, yeah we don't let them go out, we try to steer them. We're not really bound by a pacing guide. And our other teammate is. And so that's where it's a little disjointed, too. Cause she likes to have, you know, 'What am I teaching this week? And when do I have to finish teaching it?' So, it's hard, too, you know? It just depends.

Carmen, too, mentioned that she did not use pacing guide or go "page by page" in their textbook. Rather, Carmen described supplementing instruction with resources like the Van de Walle text. "There's certain things I use and there's certain things I

totally get rid of.” Carmen concluded that she and her fellow GLG members had “conflicting ideas on pedagogy and instruction.”

Carmen mused that one of the reasons for a lack of trust among their group surrounded a lack of content knowledge. “We don't have the same level of trust or comfort that like fifth-grade has. So, and that has to do with like content knowledge, too.” Carmen also described teaching differently and not going ‘by the book’ because of her previous teaching experiences with a population of students that needed large learning improvements. This goal of helping students shaped Carmen as a teacher.

I've always taught differently. I've had to. I came from Elm. You know, you can't go by the book. And you have to look for different things. Because those kids are, they're missing so much when they get to school, and you've got to make those same gains.

In summary, Carmen and Bertha’s similar goals of effective teaching differed from the other two members. Whereas Carmen and Bertha’s views on teaching centered on conceptual awareness with students continually reflecting on the learning process and making connections by analyzing patterns, the other two members viewed teaching as traditional and driven by students mastering skill sets. Both Carmen and Bertha described a student-centered focus to instruction and the autonomy to deviate from pacing guides based on the interests of students. Carmen speculated on differences between these two subgroups being because of a lack of content knowledge and prior experiences teaching different student populations that necessitated not teaching “by the book”. Together, these data suggest a lack of shared values on effective teaching.

Misalignment on how to spend collaboration.

Both Carmen and Bertha described a lack of agreement on how the fourth GLG should spend collaboration. Both Carmen and Bertha wanted to spend time discussing mathematics concepts, whereas the other half of the GLG did not. Carmen and Bertha described an attempt to investigate connections among multiplication and division as a GLG and use student samples of work to discuss ways to teach multiplication without relying on an algorithm. Yet the GLG did not accomplish this goal – Carmen noted that “the next PLC comes around and then half of us have them and half of us don't have it. So it makes it hard.” Bertha also noted the failed attempt to agree on how to spend collaboration time.

And so in the beginning we started talking about like place value, what is it, what does it consist of, what are the major areas the kids have to know about it. And we started talking a little bit about it. But then it kind of just faded away.

In fact, other group members stated that, “We don't want to do what you guys [Carmen and Bertha] are doing. It's too like in depth, kind of stuff.” Instead, others group members wanted to discuss playground duty responsibilities. Bertha suggested that determining playground duties could be done over email so that their GLG could discuss “important things that would matter in the classroom.” In doing so, Bertha described that their GLG could be more like a “true PLC,” where teachers “talk[ed] about math or language arts or writing, and what are we doing, and how do we get this across to the kids?” These situations left Carmen feeling frustrated due to the lack of “really talking about the concepts and talking about the questions and talking about the math.” Thus, Carmen and Bertha’s goal of spending time discussing mathematics and

questions to ask students was not shared by other GLG members.

An important facet to the GLG centered on the role teacher unions played in shaping collaboration time. Carmen described that one of the members on her team (but not Bertha) represented a teacher union. This teacher was familiar with many of the activities and guidelines stated by the union, in particular, on how PLC meeting time must be teacher-driven. Carmen described that this idea influenced the dynamics of her GLG.

There's like a very big tug of war going on right now between the union and the district and like, what you can have teachers do. And what you can't have teachers do. And what you use PLC for. And there's a clause in there that says in PLC that it has to be teacher-driven, and teacher, like decided upon. So, if two of the four people on the grade level want to do lesson study, but two other people, or one other person who doesn't want to do lesson study, we can't make those people do lesson study. And they can turn around and go to the union and say, 'They're making me do this. This is, I don't want to do this. This is not what I want to spend my PLC time on.'

Both Carmen and Bertha believed that union rules played a role in shaping the kinds of activities their GLG engaged in. In this case, union rules seemed to limit all four teachers engaging in similar activities, like those for lesson study.

A final point to a misalignment of values and goals lay in the desire of Carmen and Bertha to form a separate group. Due to her grade level collaboration as “the biggest waste of time,” Carmen expressed a desire to separate from her grade level group to form a subgroup with Bertha. Carmen described that she and Bertha approached their principal to see if they could have their own collaboration time separate from the other two teachers. “I asked Ron to just let Bertha and I have a

separate PLC. And he won't." The principal administratively regulated that she and Bertha continue to work together with their formally arranged GLG. Thus, Carmen's goal to have a separate meeting time suggests a misalignment of values, goals, and norms among the fourth GLG. Although efforts were made by the whole GLG to work together, the goals of Carmen and Bertha ultimately differed from the goals of the rest of the group. As Bertha stated, "It's hard. It's just been Carmen and I. It's a team of four, but that's pretty much it, just her and I."

In summary, Carmen and Bertha described a difference in how each member wanted to spend their collaborative time. Whereas Carmen and Bertha both wanted to spend time discussing mathematics concepts, other members were not interested. Instead, they often focused collaborative meetings on housekeeping issues like playground duties. Union rules played a role in shaping the kinds of activities of the group. The lack of alignment on how to spend collaboration time eventually led to Carmen asking the principal for permission for Carmen and Bertha to form a separate fourth-grade group.

Summary of fourth GLG integration.

The culture of the fourth GLG arose from compulsion and was one of contrived congeniality rather than collaboration (Hargraves, 1994). Integration about shared values, goals, and expectations varied with respect to three themes within the fourth GLG. First, the views of professional inquiry varied among members. Whereas Carmen and Bertha described a desire to continue their professional learning, often through the norms of attending district workshops and through discussing issues of teaching and learning mathematics with others, other GLG members lacked desire to

engage in the activities of discussing mathematics, reading articles, and researching on the internet. Both Carmen and Bertha described a difference in ways of reaching goals between them and the other two members of the group. Though they might share similar overarching goals of wanting students to learn, “how we go about it, how we want to improve, it's just that's the difference.” Additionally, both Carmen and Bertha described that their GLG members viewed them as “intense”. This suggests a difference of goals on professional inquiry between Carmen and Bertha and the other members of their GLG.

Second, views of effective teaching were reported to differ among GLG members. While Carmen and Bertha both described similar goals of effective teaching, they did not perceive these goals to align with goals of the other group members. Whereas some GLG members views on teaching were described as traditional and driven by students mastering skill sets, Carmen and Bertha’s views on teaching centered on conceptual awareness with students continually reflecting on the learning process and making connections by analyzing patterns. Both Carmen and Bertha described a student-centered focus to instruction and the autonomy to from pacing guides based on the interests of students.

Finally, the group lacked agreement on how to spend their time together. Whereas Carmen and Bertha both wanted to spend time discussing mathematics concepts, other members were not interested. Instead, they often focused collaborative meetings on housekeeping issues like playground duties. Union rules played a role in shaping the kinds of activities of the group. The lack of alignment on how to spend collaboration time eventually led to Carmen asking the principal for permission for

Carmen and Bertha to form a separate fourth-grade group. Carmen contrasted how the school looked from the inside to what she discovered on the inside with regards to varying levels of instruction.

Yeah, it's interesting. It's a really pretty school on the outside. And it's really pretty on the inside. But when you start pulling back the layers of instruction, it's not always what it looks like, you know. You can walk down the halls and everything looks beautiful and everything's brand new. But, instruction is not always at the same level. They're not asking the same questions.

Integration of fourth PLC.

As suggested by integration results for fourth GLG, the two Project X teachers Bertha and Carmen formed a fourth-grade PLC. Both Bertha and Carmen aligned in their views of professional inquiry, shared similar visions of effective teaching, and were in agreement on how to spend collaboration time. Together this suggests high levels of integration (See Table 5-5). In the following paragraphs, I describe evidence to support these claims.

Table 5-5. Integration themes for fourth PLC.

Theme	Details
Alignment on Visions of Professional Inquiry	desire to improve teaching attend district trainings
Alignment on Visions of Effective Teaching	conceptual understanding, not mastery of skill autonomy about “wherever the kids take us” not pacing guide what good solutions look like
Alignment on How To Spend Collaboration	discuss mathematics and students’ mathematical thinking

Recall from Chapter 2 the definition of a PLC as including: shared beliefs and understandings, interaction and participation, interdependence, concern for individual

and minority views, and meaningful relationships.

Alignment on visions of professional inquiry.

Both Carmen and Bertha shared beliefs about professional inquiry, with the shared goal to continue their professional learning about teaching. Bertha stated that her goal included to always learn about teaching each year and to “outdo what I did the year before, or improve on it. Or think of it in a different way. Because I know it's not like, ‘Well that's it. That's all there is to it.’ There's always something.” Carmen also described a goal to keep growing her ability to instruct students. As previously described before, both Carmen and Bertha participated in district trainings about Common Core, signing up for any professional development offered in the county for math, science, and social studies. “Anything related to Common Core. Because we wanted to know and have the clearest picture possible for when we start next year,” Carmen described. They also both shared a similar way of reaching their goals, like a desiring a focus on discussing mathematics during collaborative meeting like.

Alignment of views of effective teaching.

Carmen and Bertha aligned with respect to their views of effective teaching, which they both saw as meaning teaching conceptual understanding and metacognition to students. Both Bertha and Carmen described similar goals with respect to what constituted effective teaching, placing an emphasis on empowering students to understand and be able to justify multiple solutions. Bertha described that effective teaching involved students thinking in multiple ways about a concept and seeing the connection between a concept and real-life situations.

If I can get the kids to think about it in different ways, and if I can get them to understand that it's useable and it relates to your life - maybe not now, maybe now, later when you're a grownup - if I can get them to value it and say, 'Wow this is really important,' then that was an effective lesson.

Bertha continued to say that asking questions, explaining ideas, making arguments, generalizing, and connecting concepts to each other also played an important role in what is effective teaching.

If they can ask questions of each other, ask valuable questions of themselves, if they can explain it, if they can argue it, if they can make generalizations, if they can connect from one thing to another. And understand that everything's connected. It's not just like 'Well, we're learning writing right here, and that's it. Put it away and now we're going to do reading.' No, everything. If they can understand that everything is connected. Everything you do has a purpose. And one thing leads to another, whether it's math or writing or reading or whatever, if they can understand that, that's what I consider, you know, effective teaching, effective lessons.

Carmen also highlighted the importance of multiple solutions for student thinking when describing effective teaching. She stated that, "I think effective teaching is trying to get every student to realize that there is no one right way to do everything. There are many right ways. There's maybe one right answer, but there are many ways to arrive at that right answer." Carmen also pointed to the importance of making arguments and generalizations in learning.

Getting kids to process and interpret information, and draw conclusions for themselves. That I'm not telling them, you know? And teaching kids, like empowering them to, to disagree. To disagree with me, to disagree with their friends, to do it in a way that's respectful, but empowers them to, to have differing opinions. But that they better have a reason for their opinion. They better

have something that can justify what they're saying, what they're thinking, what they're doing.

Thus, Carmen and Bertha focused on the importance of multiple ways of thinking about concepts, the importance of explaining and justifying, and the ability to connect different concepts to one another. Both Carmen and Bertha's responses suggest an alignment of goals for teaching and what they expect from students. Additionally, Bertha and Carmen were also both empowered with the autonomy to focus on "wherever the kids take us" rather than strictly adhere to a pacing guide.

Alignment on how to spend collaboration.

Finally, Carmen and Bertha align with respect to how they wanted to spend collaboration time. They both participated in conversations about mathematics, reporting engaging in discussions about mathematics three to five times a week together. "Carmen and I do talk a lot. She helps me with math, and I help her with language arts. So. I like that a lot. I've learned a lot about math talking to her." They both wanted to investigate student work on topics like multiplication to investigate ways to teach the subject other than by using the standard multiplication algorithm. When further detailing what occurred in their conversations, Bertha elaborated about asking Carmen questions about mathematics, how to respond to students' mathematical thinking, like checking the validity of statements given by students during class with Carmen.

And so, if the kids bring something up, and it stuns me, I'm like, 'Oh my god I don't even know if that's correct.' And they're asking me, 'What do you, you know, what do I think?' 'I don't know, what do you think?' And so, I kind of just play it off for a little bit. And

then, you know, I'll ask Carmen questions. 'Oh, the kid brought this up. Is this, you know, is this a way that I can see it?' Or, 'Is this a correct, his or her correct path? Are they thinking it through correctly?' And so, you know, she walks me through it. Or, she says, or if there's a question that I come up with, I always run it by her. Like, does this make sense?

Thus, Bertha described a shared norm of asking each other questions about mathematics and student thinking. Carmen responded to these interactions by addressing the mathematics content and strategies to teach the content, Bertha described.

Carmen also described that she and Bertha both worked together to understand subjects.

Bertha and I collaborate a little bit. But it's more of me leading her through what I'm doing. And like, systematically like why it should happen in a certain way. And questions and conversations that should be had.

Due in part to a feeling of “being torn in so many different directions” and it feeling like “survival of the fittest” this school year, Carmen explained that they have not discussed other topics as much as Carmen would have liked.

But even that is limited. And I kinda feel like I dropped the ball with her because she needed that with me. And with Common Core, we're just being torn in so many different directions. That I think midyear it became survival of the fittest. Like, we're both trying to process as much information we can. And so she kind of went into a language arts world. And I went into my math world. And we weren't talking as much as we should have been.

Thus, Carmen also acknowledged that each had their niche where they served as the lead expert. Carmen also expressed a feeling of regret in the change in how she collaborated with Bertha due to Common Core implementation.

Summary of fourth PLC integration.

In summary, this fourth PLC exhibited an alignment of views on professional inquiry, views of effective teaching, and how to spend collaboration time. Both Bertha and Carmen describe a goal to continue their professional learning. Bertha noted that she and Carmen both attended district training when possible. Both Carmen and Bertha viewed effective teaching as teaching conceptual understanding of the content, with a focus on justify multiple mathematical solutions. This stands in contrast to how other teachers in their group who might value effective teaching as a process of mastering skills and standards. Bertha and Carmen also were empowered with the autonomy to go “wherever the kids take us” rather than strictly adhere to a pacing guide. Bertha and Carmen reported to have engaged in discussions about mathematics three to five times a week about mathematics, how students reason about mathematics, and how to respond to students’ mathematical thinking. Conversely, Carmen deepened her understanding of language arts as Bertha served to lead those conversations. The presence of these three themes suggest a high level of integration.

Integration of fifth GLG.

Recall that the six teachers teaching fifth-grade at this site include three former Project X teachers all interviewed for this study, two non-Project X teacher (not interviewed), and one special education teacher who sometimes joined meetings. The group met once a week for approximately 50 minutes for collaboration time. Mia transferred to the site at the beginning of the school year, arriving from the same school where Carmen and Bertha previously taught. Ben served as a mathematics coach during Project X.

Interview data for the formal fifth grade level group suggests medium levels of integration (See Table 5-6). In the following paragraphs, I describe evidence to support this claim.

Table 5-6. Integration themes for fourth GLG.

Theme	Details
Moderate Alignment on Visions of Professional Inquiry	Ways to improve learning Embracing the unknown in learning process
Varying Visions of Effective Teaching	conceptual and investigating vs. mastery of skill described vs. enacted views of teaching
Misalignment on How To Spend Collaboration	focus on understanding the Common Core Standards, yet lack of structure on how to do it

Fifth GLG Integration.

At the time of the interview, Mia had been teaching at her current site for approximately eight months, though had taught for more than five years at Carmen and Bertha's prior site. Ben had taught for over 23 years across a number of sites. Jimmy had been teaching for more than five years.

Moderate alignment on visions of professional inquiry.

Jimmy, Mia, and Ben all reported participating in and leading professional development trainings in their district. They each served as a lesson study coaches during a district-led cycle of lesson study in the beginning of the school year, supporting teaching, who were often new to lesson study, in learning about what is lesson study, planning the research lesson for three hours, and teaching, observing, and debriefing the research lesson for one day. Ben also described facilitating

workshops with Principal Ron for teachers to discuss the key shifts between the old and new standards. Principal Ron and Kimmy concurred. Kimmy stating that Ben had been “really sharing a lot at his school site and opening people's eyes with some stuff.” Kimmy noted that Ben and Mia would most likely help the principal support lesson study at their site. About the fifth grade teachers not interviewed for this study, Kimmy stated that Todd was “very open to learning” and worked well with Ben, and another had participated in a grant, although not Project X.

Despite participation in district trainings and positions of leadership, there was not an alignment of teachers’ professional goals. Jimmy reported that he did not believe that members of the fifth GLG shared a clear goal. Jimmy was not clear what their goals were. “To be honest I don't even know what the goal is for most of the people in our meeting. I mean, I could tell you what one or two probably think, but yeah.” He described a relationship where some teachers resisted the current direction of the district.

Some of it [the resistance] comes from the district, and the way that we interpret what we should be doing. I think that there's some people that feel like if the district has any kind of say as to what we should be doing, then we're going to do the opposite. If the district says that we shouldn't talk about procedural stuff in a PLC, then we're gonna spend our time talking about procedural. You know, almost a defiant, you know, kind of a.

Though Jimmy was not necessarily a “rule-follower”, he would “try to go in that direction” if he agreed with it. “I want to get in and look at the way kids are learning, and look at how we can best impact that, you know. And so I want to look at student work.” Hence Jimmy’s goal of examining at student thinking did not appear to be

shared by the whole group.

Like Jimmy, Mia also expressed misaligning values and expectations of the GLG. Mia described that some of her colleagues wanted to engage improving instruction while other did not.

There are a lot of people through the [Project X] cohort who welcome that time where you've spent an hour just considering problems, and talking about different strategies. And no one's really done more than one problem but we've talked about all the components of it [...] And then there's sometimes that you know we'll, we were able to do this project and do this... 'Well we're not there, but you know whatever.' So our goals are different, I think. I don't know that they can ever be fully aligned.

Mia labeled the work of her GLG as more “coordination rather than collaboration,” stating that each person with “their likes and dislikes” will discuss issues if there is an agenda.

Moving here, there are great teachers. And I am new to this school, so the culture is new. But I've known the people for a while. But certain teams, they have their likes and dislikes. And they have, you know, we are all in our niches somewhere. We have our comfort zones. And so we talk if there's an agenda. Sometimes we'll analyze, sometimes we'll, um, it's more the coordination rather than collaboration. So. It hasn't been what I'm used to, yet.

Mia contrasted this type of “coordination” with collaboration at her previous site where “we were very sisterly, and we were all friends, we had kids together. So we tended to be the other half of that team,” planned projects and units together, and shared each other’s students while teaching. “It was very, I, it just like I said, it helped me survive. It helped me teach. It helped me become who I am. I have ideas from them, they have ideas from me.” This was not the case at her current site. Due to these reasons, Mia concluded that “our [GLG] goals are different, I think. I don't know that

they can ever be fully aligned. I don't know. [*laughs*] That's just me.”

Ben highlighted a complex relationship with teacher collaboration. Ben described times of non-collaboration where “[w]e just do our own thing. We don’t really collaborate other than what we have to.” Ben saw the main goal for GLG meetings was trying to understand the Common Core Standards, what to teach, and how to teach it in different ways. “That’s [understand the Common Core] our number one goal. And it’s a work in progress.” He gave the example of understanding how to score new tasks with a new rubric with his team, which I confirmed with field notes of some of these meetings. Yet Ben also reported that collaboration at his site was the most productive collaboration he had experienced in 23 years of teaching.

What’s going on in education is exciting, and the people that I’m working with, we collaborate very, which I’ve been at places where we don’t collaborate very well. So you have teachers that just close the door, leave me alone, I’ll do my thing. You do your thing. And I’ve never been at a site where we are collaborating this much.

Ben also explained that valuing the process of coming to understand a concept involved uncertainty. “It's okay for me not to understand this. But I'm not going to give up there. I want [to] still figure out a better way to do this.” In particular, he described working with GLG member Todd to create their own instructional concept that involved students using whiteboards on all surrounding walls during instruction. This shows Ben’s desire to continually improving his own understanding of mathematics and teaching mathematics. Thus, on one hand, Ben described minimal collaboration with teachers in his GLG, in part due to the main goal of each person trying to understand the Common Core Standards. On the other hand, he described his

current experience as the most frequent and productive collaboration among teachers and administrators in his 23 years of teaching due in part to the change occurring from the Common Core Standards.

Though the GLG consisted of strong and experienced teachers understanding implications of the Common Core Standards, there did not exist a clear and common way to develop professionally together. Jimmy, Ben, and Mia each stated that they were interested in engaging in lesson study to professionally develop as teachers. Yet not all members of the GLG had the goal of engaging in lesson study to reach their common interests, suggesting a misalignment in terms of the means of professional inquiry. Jimmy suggested a lack of alignment of goals across all members of the fifth GLG when he noted that his group's goals should be more aligned due to the high number of former Project X members working at his site. He reflected midway through the interview that it should be likely for the group to collaborate in a lesson study fashion since the majority of members of his grade level group participated in Project X.

If we were to get focused and, *[pause]*. I think it's hard right now because we have. There are two, two out of the five people. No, three. Three out of five. Okay. There are three people that went through Project X. So, it actually, we should be doing a better job convincing everyone else.

When asked what hindered their ability to engage in a lesson study, he attributed it to misconceptions about the amount time and work it would take to engage in lesson study.

I think that it might be the, the misunderstanding or the misconceptions that they have about the process and that it's gonna entail more work. And, and so I think that's kind of, turns people off. You know. And at the same time, I mean, most of these, most of these teachers are putting in plenty of time anyway. It's not like they're flakes, you know? So. I don't know what it is, you know. I think that, just it's that uncertainty in thinking that, I don't want to put out all, do all this work.

This theme will be discussed in greater detail in Chapter 7 with teachers' conceptions of lesson study and what would support it. Field note data from weekly meetings of this GLG confirmed that although teachers engaged in professional inquiry into their practice, not all teachers wanted to go about it in a similar way. In particular, Todd was not committed to the idea of using lesson study as a vehicle for reaching their professional inquiry goals. Other field notes suggest that the other fifth-grade teacher was close to retirement, and might not have been interested in engaging in intense training.

In summary, the fifth GLG members generally had a general shared desire to improve practice. Ben, Mia, and Jimmy were involved in district trainings, like facilitating the district-led lesson study and workshops on Common Core training. Yet there was not a clear alignment on teachers' views of professional inquiry. Jimmy and Mia suggested a lack of alignment of goals for teacher collaboration in their group, and Ben's data suggested a focus on trying to understand the Common Core Standards. Additionally, there was not consensus among group members on how they approached professional inquiry, with Jimmy, Ben, and Mia interested in engaging in a GLG lesson study with field note data suggesting that the other two teachers were not interested. Together this serves as evidence for moderate alignment of views on

professional inquiry.

Varying visions of effective teaching.

Jimmy described a difference in views on effective teaching among GLG members. There were “difference in opinions” on how each teacher structures teaching - Jimmy saw it important to focus on conceptual understanding, while others wanted to focus on practicing skills.

I think the main disa-, disagreement would be on practice. You know? Doing less investigation and more practice. Which, you know, I kind of feel like with the way things are going, we need to move away from that and get into the conceptual. And not, you know, not focus on the procedure. And so, I don't think it's huge, but I think it's 10% of what one person believes and 10% of what I believe, and it's that difference.

Mia also noted that her view of effective teaching changed each year as teachers underwent growth, like participating in Project X.

I think we've all felt very effective one day and not effective the next. So we all kind of debrief and talk about it. But it's changed. And I think one year we thought we were effective, and then you learn something new or you change the group you're teaching, going, ‘Ohhh’ [sigh]. You know?

Thus, Mia stated that a person’s beliefs, including her own, about effective teaching shifted as they learn more about teaching, like the teachers who participated in the former grant. Mia concluded that her GLG’s professional “priorities might be always hard to align”. Ben, on the other hand, reported that his GLG “definitely” shared similar views on effective teaching. Ben described the shared view as an openness to change in education. “A lot of teachers don't know where we're going to go. So you have some teachers who are resistant to it. Our group, we are very open to it. And

that's exciting to see.”

Related to effective teaching, was the distinction between described versus enacted views of teaching. Jimmy and Mia described a disjoint between what teachers thought about effective teaching and how they practice effective teaching. Mia stated that the common goal among her colleagues is that “we all want kids to be able to do math. I mean, we would all say that whole-heartedly.” Yet Mia expressed that “what we [teachers] do to get them [students] to do that might vary”.

You have people who, sometimes you can see, the more you work with someone the more you can see, like, well they've said that, and they've said that, but they might not have done that. Meaning, we all mean well. But effectiveness, especially in a job like ours, can be sometimes vague.

Thus a difference existed between how people describe effective teaching and how they practice effective teaching. Jimmy also described a similar discrepancy between a group member’s stated and enacted goal.

You know, to be honest, Todd has said some things in PLC that I thought, ‘Really? You do it that way?’ It just doesn't seem like the way I would expect you to do it. It just doesn't seem like, you know. And then, like I went into his classroom today and I'm watching. It's like, ‘Wow, okay. He's doing some good stuff.’ So sometimes I think it's hard when we, when we just come together as adults and talk. And we voice our opinions. We might say stuff that might not necessarily be true to what we actually do.

Note that even though Jimmy reported observing Todd’s classroom, there is not enough data to link Jimmy and Todd in a group.

In summary, there were different views on effective teaching among GLG members. Jimmy and Mia both described the GLG as not sharing similar goals for instruction – for instance whereas Jimmy saw it important to focus on conceptual

understanding, others wanted to focus on practicing skills. Mia acknowledged that teachers' views on effective teaching were undergoing change, and thus were difficult to describe. Ben believed the opposite, describing a view on effective teaching as being open to change in education as shared by his GLG. Additionally, both Jimmy and Mia noted a difference between how some teachers describe effective teaching and how they practice effective teaching. As Jimmy concluded, "We're all very strong people. We have opinions and we have, you know... And I think that we, we all kind of have different opinions of where we should be going right now."

Misalignment on how to spend collaboration.

One theme in the data centered on group members' desire to have greater focus and direction in collaborative activities. During the semester I visited their weekly meetings, the focus was on better understanding the Common Core Standards. For instance, one meeting consisted of examining students' performance tasks across three different classrooms to understand how to apply a new rubric. Yet Jimmy, Mia, and Ben each expressed a desire to have a greater focus and structure to GLG meetings. Jimmy described his GLG had potential to be more productive than its current state, which was not functioning well. He stated one way to make his group members more productive and less "dysfunctional" was to add structure to activities.

I think we could be, we could be more productive. I think that sometimes if we had a little more guidance as to specifically what we needed to do. Because sometimes we'll focus on student work, assessments, we'll look at, you know. And then sometimes we'll be doing something else. I think that any time we get together there's always good conversation. And, but I think that we could probably do a better job of focus.

Though he described activities of conversing about and examining student work and assessments, Jimmy expressed a desire to have a greater focus on visions of what good teaching was among his group. Jimmy noted the flexibility from his principal as both beneficial and limiting.

Our principal has been a lot more flexible. And in doing so, I think it's kind of, it's good. But it's also created issues. Because now it's kind of a free-for-all, and we need to reign things in. And, so. Yes, I think that they've done a good job. But at the same time, I think that some times we need a little more structure and specificity.

Consequently, Jimmy thought that his group needs to “reign things in” and have “more structure and specificity” during their meetings.

Mia also implied a desire for greater focus within their GLG. She described that her current site had more freedom and less structure than her previous site. Compared to her previous work site, her current site had “more freedom to talk about what you want [...] in that freedom, sometimes, you know, people. It could go either way. Freedom could be a good thing or a bad thing.” Mia reported that she was on a team that “seldom want[ed] to collaborate in that way” that she did with Carmen at their previous site, where they “really plan together.” Mia posited that the presence of unstructured collaboration could be due to the fact that school leaders were not telling teachers exactly what to do. She also thought that it could be “just even personalities. I mean, honestly, first time ever I’m working with three males on a grade level team.” Thus, Mia eluded to both affordances and limitations in having freedom to discuss topics and a desire to have conversations with her GLG.

Finally, Ben too noted a lack of structure among members of his GLG about

“how to do things in the classroom with your colleagues.” He stated that he wanted to have more structure to their activities. When asked about the goals of his group, he stated that he wanted to engage in lesson study since it “provides a structure, a matrix so to speak, on how to do things in the classroom with your colleagues.” He noted that they current “don’t really have that structure. And I think lesson study would provide that.” Thus, each of the members interviewed in this GLG described a lack of focus on how to spend collaborative time together. These data suggest a lack of shared goals among group members.

Mia described wanting to spend time debriefing with her GLG members at the end of the year to share what worked well. She stated that debriefing about the school year would help make her feel less isolated as a teacher.

I was just talking to Ben about our team. Going, This is the end of our transition year. I would love to debrief, and take the time to say, ‘Okay, well in this content area, or in this, whatever this was with different media or poetry or myths, what was effective? What didn't we do that we need to? What really worked that we want to make sure that we do?’ Because isolation doesn't help. And if I'm debriefing on my own year with my own self, [*laughs*] that's going to be so ineffective!

This suggests that Mia desired that her GLG spend time collaborating together on what worked well during instruction over the past year. Ben also described a lack of structure among members of his GLG on “how to do things in the classroom with your colleagues.” He stated that he wanted to have more structure to their collaborative activities. When asked about the goals of his group, he stated that he wanted to engage in lesson study since it “provides a structure, a matrix, so-to-speak, on how to do things in the classroom with your colleagues.” He noted that they currently “don’t

really have that structure. And I think lesson study would provide that.” Thus, each of the members interviewed in this GLG described a lack of focus on how to spend collaborative time. Additionally as described under professional inquiry, Jimmy, Ben, and Mia each expressed an interest in engaging in lesson study with their grade level group. Yet there was misalignment in terms of the means of professional inquiry, as inferred through field note data of Todd’s lack of interest in engaging in lesson study and the other fifth grade teacher’s potential retirement. Interview data with Kimmy posited that Todd might be influencing others due to his charisma and lack of a solid foundation in mathematics. Todd is experienced in many aspects “so people tend to follow [him]”.

Finally, recalling Jimmy’s description of not knowing his GLG’s goals also supports a misalignment on how to spend collaboration time. He described that some teachers would “do the opposite” of what the district said teachers should be doing in an almost “defiant” way. “If the district says that we shouldn’t talk about procedural stuff in a PLC, then we’re gonna spend our time talking about procedural.” This also indicates a disagreement on how to spend collaboration time.

In summary, the fifth GLG lacked agreement on how to spend collaboration. Although the group was engaged in discussing aspects of the Common Core Standards, like using students’ responses to performance tasks to understand how to apply new rubrics, Jimmy, Mia, and Ben each described a desire to have greater focus and direction in collaborative activities. Jimmy wanted more “structure and specificity,” Mia noted that “freedom could be a good thing or a bad thing,” and Ben wanted a “structure” like lesson study so that he and his GLG members could discuss

issues related to teaching in the classroom. Additionally, Jimmy, Ben, and Mia expressed an interest in engaging in lesson study while two other group members did not appear to want to. Finally, Jimmy noted that some teachers would “do the opposite” of what the district said teachers should do in an almost “defiant” way, further indicating a misalignment on how to spend collaboration time.

Summary of fifth GLG integration.

The fifth GLG had moderate levels of integration, or shared values, goals, and norms about teaching, with respect to three different themes. First, there was moderate alignment on views of professional inquiry teachers’ professional inquiry. The fifth GLG members generally had a general shared desire to improve practice. Ben, Mia, and Jimmy were involved in district trainings, like facilitating the district-led lesson study and workshops on Common Core training. Yet there was not a clear alignment on teachers’ views of professional inquiry. Jimmy and Mia suggested a lack of alignment of goals for teacher collaboration in their group, and Ben’s data suggested a focus on trying to understand the Common Core Standards. Additionally, there was not consensus among group members on how they approached professional inquiry, with Jimmy, Ben, and Mia interested in engaging in a GLG lesson study with field note data suggesting that the other two teachers were not interested. Together this serves as evidence for moderate alignment of views on professional inquiry.

Second, members of this group had varying visions of effective teaching. Jimmy described the GLG as having a “difference in opinions” on how to structure teaching – whereas Jimmy saw it important to focus on conceptual understanding, others wanted to focus on practicing skills. There was an acknowledgement that

teachers' views on effective teaching were undergoing change, and thus were difficult to describe. Ben believed the opposite, describing a view on effective teaching as being open to change in education as shared by his GLG. Additionally, both Jimmy and Mia noted a difference between how some teachers describe effective teaching and how they practice effective teaching. As Jimmy concluded, "We're all very strong people. We have opinions and we have, you know... And I think that we, we all kind of have different opinions of where we should be going right now."

Finally, there was little agreement on how teachers should spend collaboration. Although the group was engaged in discussing aspects of the Common Core Standards, like using students' responses to performance tasks to understand how to apply new rubrics, Jimmy, Mia, and Ben each described a desire to have greater focus and direction in collaborative activities. Jimmy wanted more "structure and specificity," Mia noted that "freedom could be a good thing or a bad thing," and Ben wanted a "structure" like lesson study so that he and his GLG members could discuss issues related to teaching in the classroom. Additionally, Jimmy, Ben, and Mia expressed an interest in engaging in lesson study while two other group members did not appear to want to.

Integration of Project X PLC.

I now describe the last group in the case called Project X PLC. It consists of Carmen, Bertha, Jimmy, Mia, and Ben. This PLC described an overall high level of integration among group members (See Table 5-7). Recalling the five requirements for PLC – shared beliefs and understandings, interaction and participation,

interdependence, concern for individual and minority views, and meaningful relationships – I demonstrate how these teachers met these requirements.

Table 5-7. Integration themes for Project X PLC.

Theme	Details
Alignment of visions of professional inquiry	learn by doing
Alignment of Visions of Effective Teaching	good teaching not mastery of skill willingness to learn similar goals but different paths

Alignment of visions of professional inquiry.

Participants in this group described a similar approach to professional inquiry, or how they want to work together to improve their practice.

Teachers in the Project X PLC described conversing with one another to inquire into their own teaching practice. Mia described conversing with Ben and Carmen in large part because of shared values. “I could talk to both of the because our relationship just lends itself to that. And that’s never really in a formal setting because I know they’ll take the time to talk to me, and they value doing things like that.” Mia noted the importance of having a “culture of just talking and having these informal discussions about learning throughout the project.” She stated that she was comfortable suggesting new ideas to the Project X cohort and discussing what students were thinking. “And the way that we’re comfortable going, ‘Man, I really tried this’ and ‘You know, the kids aren’t really getting this.’”

Jimmy also described, “constantly having this open dialogue” and feeling comfortable during conversations with Carmen and Mia, due in part to similarities in questions, strategies, and a shared former grant experience.

We do all of our PLCs, our professional learning communities, in grade level. But then just as professionals, we're constantly having this open dialogue. You know, lunch time we're talking. And I find that I do more of that with Carmen just because I think we think alike. And we, we have similar questions and strategies.... I have conversations with her and we're constantly hitting things off each other. And I think that's because I feel comfortable with her because we worked with Project X.

Jimmy described having conversations about “what kids are seeing”, how to present ideas to their students, how to question students, and the “little connections that they’re making” with Carmen and Mia. Jimmy noted that he would be collaborating with Mia regardless of whether she taught the same grade because “she's part of that, kind of that core of, that informal. You know, we would be doing it regardless.”

Mia described informally conversing with Ben and Carmen because she knew they would listen.

I could talk to both of them [Ben and Carmen] because our relationship just lends itself to that. And that’s never really in a formal setting because I know they'll take the time to talk to me, and they value doing things like that.

Mia described asking Ben and Carmen questions about understanding aspects of the Common Core Standards. Bertha also described shared goals and norms of conversations while interacting with both Ben and Carmen. Bertha stated that they often discussed what makes a good lesson in mathematics with them.

Ben and myself and Carmen, we have a lot of conversations about, you know, what constitutes a good lesson in math or language arts or writing or. You know, what's the difference between such and such. Or, did you know this? Or, you know, just in general. Yeah. It's us three.

Carmen described conversing with Bertha, as shown in the fourth PLC, and also Ben. She often discussed questions with Ben and “we'll go back and forth.” She continued, “If he has a question that he thinks I can answer, I will try to find the answer for him, and I'll do the same thing, he'll do the same thing for me. So that's cool.” Carmen also confided with Jimmy about teacher collaboration in her grade level.

Another theme for the Project X PLC regarding professional inquiry centered on sharing similar professional goals. Mia described that the goals of Project X teachers at her site were shared “for the most part.” The common goal was “to study what we've been, or practice what we've been studying, and to debrief, to look at student thinking or to look at student responses.” Mia stated that sharing common goals allowed these teachers to work together productively, which in turn created camaraderie among them.

But definitely once there's a camaraderie of, we all want to make this attainable. We see that it's not just, ‘Here's this book, here's this page,’ then right away I like you. Right away I want to hear what you have to say in that respect. So whether new or old friends, it seemed like we had a common bond.

She noted, however, that there were varying levels of participation. “Always within a project there are different, different levels of intensity with different people, and then even afterwards too.”

Jimmy also described an alignment of goals and aspirations within the Project X PLC group. He described the professional inquiry goals of his PA PLC to include having an interest in looking for and testing new ideas, investigating student thinking, and motivating students to learn.

I think that the people from Project X, for the most part, are, they're more eager, more inclined to look for outside stuff, make connections elsewhere. Just see education as a bigger picture. And, and I think, I don't think it's a coincidence. I think that the people that went into Project X kind of had that mindset anyway, whether, you know, they had gone to Project X that's the way they think. And it's always looking for different things.

The “life changing” experience for Carmen, Mia, and himself helped these teachers think, do, and change in a way that they wanted to change. He elaborated to say that they each want their students to investigate and be interested in solving tasks successfully.

This is the way they think. This is what they want to do. This is how they want to change. And so. As far as those people, that type of thinking, I think our goals align. You know, we want investigation, we want the kids to be intrigued, and to, and to get into it.

Jimmy was unsure whether they learned it from participating in the former grant or whether the grant helped to nurture a disposition that was already there. “That's why we got into. Whether it was the egg or the chicken, you know, if that was the way we thought prior to Project X and then we got into it. Either way.”

Some teachers in this PLC pointed to previous experiences as helping to develop similar goals on professional inquiry. Mia commented that the context of her previous school where she worked with Carmen and Bertha helped shape the teaching

style and goals for a number of members of the Project X PLC. Mia described how they each found value in discussing their struggles to teach students at their former site:

The willingness to talk about the teaching is found when you have to struggle through that. When you are wading through kids who don't understand. And so a lot of us who have moved here, Carmen and Bertha, we started there. We were young and we had a population of ELLs [English Language Learners] or people who were retained or three or four levels behind. So you couldn't teach the traditional way. And so we saw that, and we, you know, it's just that thing. So getting to reflect on that kind of thing and going, wow! Those were the reasonings; those were the breadcrumbs for different things. Kind of seeing that afterwards going, 'Oh, maybe that was why I was more so engaged,' or more so, you know, 'Why I felt it was so effective.'

About knowing some of her current site colleagues before working at this site, Mia stated: "It was nice, though, not having to be forced in all my cohort relations." Thus, the shared experience of teaching with particular constraints at a former site helped to shape the nature of collaboration for these three teachers. These shared struggles increased their willingness to discuss together how to better prepare students.

Another shared experience of some of the Project X PLC members included a shift from not liking mathematics to enjoying mathematics. Jimmy noted that he and Carmen shared a similar background in their journey of becoming a teacher. They both were not "into math" as students but came to enjoy mathematics and see it differently as adults.

I mean, Carmen talks about getting a degree in whatever subject she could that would require the least amount of math. You know? And I was kind of the same way. And now we love it, you know? And we're just enthuse- I mean, I love teach- I'll teach math all day

long. And so I think coming to that as an adult is just that much more valuable.

Mia specified Carmen as someone who complemented her because “she sees it very, not mathematically, but in a linear fashion.” Mia, on the other hand, saw things “in a very visual way.” She continued on to say that, “Yes, I think having that cohort and with the cohort I had at Long Elementary and still people here, I've become definitely stronger. And I think we're better for it. Cause none of us knew what we didn't know, and none of us knew what we lacked.” Being able to learn from each other due to complementary perspectives helped Mia become a better teacher.

Some Project X PLC members described a similarity in the way they approached professional inquiry. Mia described collaborating with the PA PLC in a way that complemented each other's particular strengths.

I had great relationships with people through the project, and through, just relationships before the project. So went into the project with friends already. And then through the project began planning together. And being able to be able to kind of sit together and say, ‘okay, we want our kids to learn this,’ and just feed off of each other. ‘Oh, well that means we want to see this.’

Bertha and Carmen also shared similar values with respect to the way they each approached collaboration. Bertha noted that both she and Carmen were “systematic” about inquiring into their practice, where “everything needs to be lined up. I need to have this, and then this, and then this, and then this.” She contrasted this with Ben, who was “a little bit more free” about questioning his practice than she although they both shared the same goal.

Ben I find that he questions a lot of things. And a lot of the times, you know, you try to answer it. There's still another question, and he kind of goes around and around. So, I think he, I'm pretty sure if you were to ask him, he has the same goal as I do, but he's more open and free about it. And I'm, everything needs to be lined up. I need to have this, and then this, and then this, and then this. He's kind of like a little free bird, you know? If it comes, it comes, and if it doesn't, it doesn't. But I think at the end, we have the same goal. It's just that I'm systematic about things, he's a little bit more free. And Carmen's systematic about it, too.

A final theme under professional inquiry of the Project X PLC centered on a shared value of learning about professional inquiry through experiences. Jimmy, Mia, Bertha, Carmen, and Ben all described a value in learning through engaging in an activity as opposed to reading about an experience. Jimmy highlighted the importance of observing and discussing with each other rather than relying on the discussion of ideas alone.

Sometimes I think it's hard when we, when we just come together as adults and talk. And we voice our opinions. We might say stuff that might not necessarily be true to what we actually do. And so I think it's really important to get in, and, and continue to see each other. You know. Not teach in isolation. Work together, you know.

By experiencing other teachers' classrooms, Jimmy wanted to "look at the way kids are learning, and look at how we can best impact that." He described himself as a person who dives in "head first and figure it out." "I want to get in there and, 'Well let's try this, and try that. Try this!' You know, it's not about failing. You know, it's about figuring it out."

Mia also described learning through experiences, stating that she was "a fan of watching it happen, and learning while you watch it" while referring to engaging in informal discussions about students learning. Mia stated that it was important to have

professional development that allowed teachers to experience what they were trying to learn, as opposed to reading research about it.

You can give me a staff meeting and tell me how to be effective. You can give me a book that tells me how to be effective. I can read research and whatnot. But I won't know how until I've done it. Or until I've seen the difference between a lesser lesson rather than that, you know, oh the kids really seemed to understand what you were saying.

Additionally, Mia expressed wanting more opportunities to experience inquiring into her teaching with others so that she did not have to reflect on her own.

I think because we're teachers, we either research what we don't know, or we want to put a solution idea out there right away and not admit that we don't know. And so as teachers, we need to have programs like this that kind of inadvertently tell us what we don't know, and discover on our own, rather than someone say, 'Hey brush up on that a little bit.'

Thus, Mia expressed a desire to “delve in” to learn about the standards through reflecting on experiences to know more deeply what they mean rather than “reply on bits and pieces from staff development or emails.”

Bertha wanted the district to support teachers experiencing other teachers teaching a lesson to learn from it. “And so I think that would shift completely if the teachers understood by listening and seeing what it could be like, and what it could sound like. I think that's powerful.” Carmen described how she believed that “most learning occurs by doing things and by experiencing things”, recalling what someone said at a conference this year as “it’s fine to tell kids what to do as long as you don’t expect them to remember it.” Finally, Ben highlighted the importance of learning by doing rather than reading about it.

Going through the process is where you learn about your content that you're teaching. I can read it in a book, and I can you know, see it go on the internet and research it. But there's something about meeting with colleagues who all have a different opinion. And it's in that struggle that I think it broadens your thinking. Hearing teacher a, teacher b, teacher c, 'no I think it's this way,' 'I think it's that way,' 'no I think it's that way.'

He said that, "instead of telling me what I need to know [and] telling me how to do it, help me discover how to do it. And in that process you discover the why." Ben summarized the view of learning through experiencing well when he stated:

It's the whole process, it's that collaboration, it's working with your colleagues to really understand what the concept is and how to convey that information to the kids. But not just how to say it. How do I get the kids to discover this? So what I would like to do is see the teachers be more involved instead of the speakers doing so much talking. And that's the way I like all professional developments. And when I'm involved, in charge of a professional development, that's what I want to do. I just want to facilitate more, instead of being up there lecturing. I want the participants, Okay, so this is what I want you to do, and then we can talk about it.

Thus, by teachers involving themselves more in their own inquiry into professional development, this will help teachers "get the kids to discover" mathematics rather than be conduits for conveying information to students. These data exemplify how these teachers valued the importance of learning through experiences.

I share one final note on the teachers' views of professional inquiry. All five of these Project X PLC members described an interest in continuing to engage in lesson study, particularly to better understand implications of the Common Core Standards. These results will be discussed in Chapter 7 where I report on all case teachers' conceptions of lesson study.

Alignment of visions of effective teaching.

Members of this PLC each described visions of effective teaching as engaging and empowering students to create and defend their thinking. Jimmy discussed how his views on effective teaching aligned with Carmen's views. He described both valuing engaging students to feel as if they "own" what they are trying to learn.

The value to me is trying to get to the answers. And I think that's what we all want. And so, I might have the answer one day, and she [Carmen] might have the answer another day. But it's about engaging the kids, getting them to, to really own what we're doing, you know? Not on the surface level. You need to own it. And how do we do that?

Although Jimmy and Carmen did not always agree on what would be good for teaching mathematics and they did not always "know the answers", they encouraged each other in an "ongoing learning process" to consider different perspectives in a productive way. Jimmy said that, "Sometimes my value or my thoughts on what constitutes effective teaching is not correct," to which Carmen would reply, "Really? You're gonna do it like that?" Conversations on what constitutes effective teaching allowed him to "stop and I think and I go, 'Oh yeah, okay. Maybe I should go around this way.'"

As described in the fourth PLC, Carmen described her view of effective teaching as aligning with Bertha's view. They both teach for conceptual understanding and for students to be aware of how they are problem solving. Carmen and Bertha also described the importance of knowing more than one way to solve a task.

Mia also demonstrated a similarity in views on effective teaching when she discussed the importance of helping students understand the mathematics. She

described that the main goals of her PA PLC included changing their philosophy on mathematics pedagogy from instructor towards facilitator and helping students to “understand what the meanings [are] behind the math” and also “how to arrive at those findings”. She commented on the importance of facilitating this way of learning for students.

The goals in Project X were to in part change our like philosophy, our pedagogy, as far as not being this instructor of sorts, but being this facilitator, this support kind of personnel person. To get you into understanding the math. And then having the student really understand what the meanings behind the math were. And how to, how to arrive at those findings. And so I think we all want that.

Mia pointed out that she, Carmen, Ben, and Bertha would see effective teaching as wanting students to know the material, and not just “three weeks from now or until the end of our grade level.” She wanted students to learn “what fractions are, where multiplication lies, what's happening when you multiply, why do you divide, what does division do?” “But we want them to come away with knowledge, not application, not recall. We want them to come away with knowledge. So I think that is our goal of my close circle.” Ben’s view on effective teaching was to help students in “discovering on your own instead of somebody giving it to you.” Thus, the goals of the Project X PLC were described as finding strategies to help students understanding the meaning behind the math.

Summary of Project X PLC integration.

Participants described an aligned vision to professional inquiry. They each described engaging in conversations about issues of practice, like “what students were thinking” or student strategies, how to respond to students’ thinking, and how to make

sense of the Common Core Standards. The Project X PLC members also shared similar professional goals, which involved collaborating together to investigate student thinking and test new ideas. Some teachers in this PLC described shared previous experiences that helped to develop shared goals on professional inquiry, like working at the same previous school (Mia, Bertha, and Carmen) or sharing a dislike for mathematics that changed during adulthood (Jimmy and Carmen). Additionally, some Project X PLC members described similar ways that they approached professional inquiry, with Mia describe how she could “feed off of each other” with other Project X members and Bertha and Carmen describing that they were both “systematic” about inquiring into their practice. But perhaps the strongest indication that these five formed a PLC with high levels of integration laid in their shared value in learning about professional inquiry through experience rather than reading research or textbooks about.

Participants also described having shared visions of effective teaching. Each member described a strong focus on engaging and empowering students to feel as if they “own” what they are trying to learn. Berth and Carmen both highlighted the importance of conceptual understanding and metacognition rather than solely mastery of skill, Mia stressed the importance of students understanding the meanings “behind the math” and how to find the solution, Jimmy wanted students to “own” the mathematics that they were learning about and to be motivated in learning it, and Ben wanted students to be “discovering on your own. Instead of somebody giving it to you.”

Kimmy described in an interview during the beginning of the school year that

teachers at this site were strongly encouraged by their principal to continue with lesson study. “Their principal is really highly encouraging them. And asking Ben and Carmen to, and probably Mia, to take the lead on some of that.” When Kimmy checked with one of the teachers at a workshop, she asked Jimmy about the possibility of doing lesson study at their site. Jimmy stated that their focus was on creating performance tasks. He said, “we [the grade level group] didn't necessarily want somebody from outside to come in and dictate what it is we 're supposed to be doing.” He continued on to say that “we really do need to do a lesson study cause that’s been valuable for us.” Kimmy believed that at least Ben and Jimmy would like to engage in lesson study, though she was less sure about Mia since she recently transitioned from a different site.

Linkage

Recall the four groups in Case 1 and their corresponding levels of integration based on emergent themes. Two formally arranged GLGs and two professional PLCs were presented. The fourth-grade PLC consisted of two Project X teachers, Bertha and Carmen, who taught fourth-grade. Bertha and Carmen worked together at a different site 2-3 years prior to this interview. A multi-grade level group called the Project X PLC consisted of former Project X participants, and included the fourth-grade PLC embedded within the PA PLC.

The two PLCs showed evidence of high levels of integration, while the fourth GLG showed levels of low integration and the fifth GLGs showed moderate levels of integration. Even a well-integrated group needs to have linkage to attract outside support for sustained growth. Thus, I now described the linkage for each group, which

means the connections to resources, people, or groups outside of a group. These were confirmed through linkage analyses.

The following graph in Figure 5-1 shows the linkage at Case 1. If there is the presence of a type of linkage from one person to another person or group, this is represented by an edge in the graph. It will be referenced while discussing each of the groups' levels of linkage.

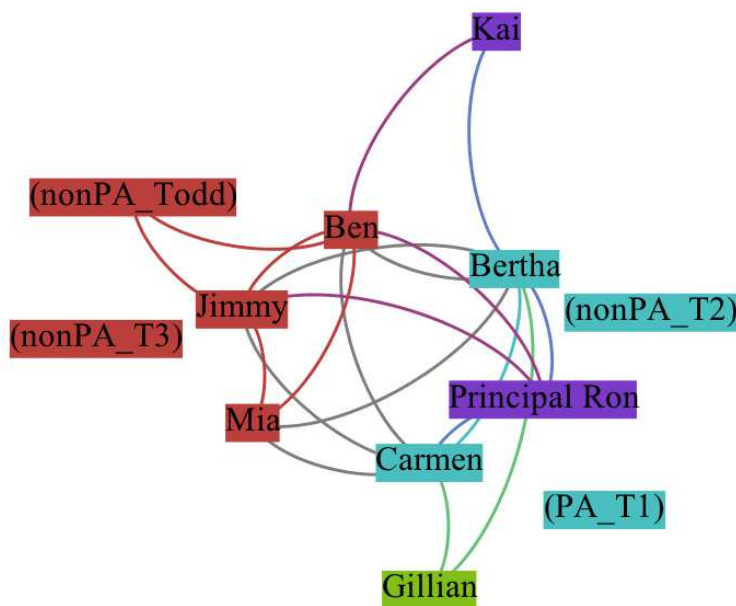


Figure 5-1. Linkage among participants in Case 1 with non-study teachers in parentheses.

Linkage of fourth GLG.

Overall, the group demonstrated weak linkage from the group to outside resources (see Figure 5-1). Recall that Bertha and Carmen expressed a divide in their GLG and lack of collaboration on mathematics teaching and learning among the fourth-grade teachers. Figure 5-1 demonstrates that Carmen and Bertha are not

connected to the other two grade level members because they do not report engaging in activities together or using them as resources to support their work. Although both Bertha and Carmen described having access to resources outside of their group, they were not utilized by the group. For example, Carmen described conversing with Jimmy about issues of her GLG. “ I was just talking to Jimmy. And I said, I. We feel, we both were saying, that we feel very much like we're being held hostage to the demands of one teacher.” Bertha noted that the principal was a useful social resource since he could provide the human resource of knowledge about mathematics due to his prior position as a middle school mathematics teacher, as well as TOSA mathematics coach Kimmy to answer her questions about mathematics. Yet these resources did not serve to bring resources to their GLG since the group members did not use them together in their GLG meetings.

Instead, both Bertha and Carmen described that their GLG focused on housekeeping issues. “And they want their PLC to be like housekeeping issues, and you know, issues with the playground.” In fact, the lack of links shows that the group did not report engaging in activity together with one another. Bertha also stated that some of her grade-level colleagues said that Bertha talked too much about mathematics. These data suggest that resources brought in by Carmen and Bertha were not used by the group.

Both Bertha and Carmen described having connections to outside of their group, which is represented Figure 5-1 with Bertha and Carmen connected to people outside of their GLG. Bertha stated that she turned to the principal and TOSA math coach Kimmy to answer her questions about mathematics. “But other than that, no I

don't have any contact. We don't have contact with any university people, or anybody in the field.” Bertha state that she wished that she knew mathematicians who used math everyday so she could plan lessons with them or so they could visit her students. Carmen “definitely” felt like she had connections to resources and people outside of her group, like to the principal or fifth-grade teacher Ben. She did not describe that any of these connections served her GLG. When asked if Carmen collaborated with her other grade level colleagues, she cited preconceived ideas as limiting their ability to connect and work together. “Not really. I think that because of the grant, and because I was new to this school, there were preconceived ideas about me and about Bertha and because we'd come from a different school and ideas like that we were going to come in and try to change what they were doing.” Carmen described limited conversations as a result of other teachers’ resistance to change.

But you're trying, you're, you're asking people to have conversations in a way that they've never had conversations before. And so they're very resistant to that. ... But every time we tried to have a math conversation, it would be turned around like we were telling them what to do. And it wasn't that at all.

In summary, although Bertha and Carmen reported having connections to people and resources outside of their group that attracted human resources, they reported not engaging in activities with the rest of their GLG that made use of these resources. For these reasons, this GLG exhibited low levels of linkage in addition to low levels of integration.

Linkage of fourth PLC.

As noted in the previous description of linkage of the fourth GLG, Bertha and

Carmen described connections to people and resources outside of their group, like their principal, fifth-grade teachers Jimmy and Ben, TOSAs like Kimmy, and district trainings that focused on understanding the Common Core Standards for Mathematical Practice (See Figure 5-1). Carmen described “definitely” having connections to resources and people outside of her group. “That's probably the thing that we are most fortunate about here,” she responded.

At ten years and longer, that we've established relationships with teachers in other schools and in other districts. And so, when a need, when there's a need or there's a question, we, we all know somebody that we can reach out to that can help us with that.

Note Figure 5-1 that shows Bertha and Carmen connected to people outside of their GLG.

Both Bertha and Carmen described the principal as a resource, particularly about mathematics. Bertha noted Principal Ron’s knowledge due to his previous position as a middle school mathematics teacher and his own social resources.

Our principal worked in Secoya. So I know he talks to people that he knows over there. And his thing is math. So I know that if I have a question I can go to him. And if he doesn't know, he has other resources that, or people, he can go to.

Principal Ron sent relevant material resources like articles, websites, and emails to Carmen and Bertha. He also served as a human resource for these two teachers by providing knowledge about particular mathematical topics and the CCSS Framework. Carmen even stated that his support was one of the reasons she chose to relocate her teaching practice to the current site.

More so than ever in my entire thirteen years, have I had a teacher, or principal, who will come in, and will, will teach lessons, and will have those Common Core kinds of questions, conversations and questions and. So he is my resource, like huge. And anything that we want related to math, whether it's manipulatives, or it's more Van de Walle books, or you know, other content related reading, he'll get it for us. If you ask for it, he'll totally find a way to get it for you. But I don't, I wouldn't say that that's like the district. That just happens to be that I'm at a school with a principal who's like that. And so because he's like that, I have those things available to me. But I also know that when I chose to come to this school, that was one of the reasons why I chose to come to this school. Because I already heard, you know, that he was a big supporter of, like, teachers who were, who were teaching through the grant. And he was a big supporter of just the kinds of conversations we were having and the lesson study. And so to me, it was kind of like a haphazard resource. Not every school has that.

Principal Ron described engaging in conversations with teachers at his site around content knowledge and pedagogy. His discussions centered on understanding tasks, instructional strategies, the Common Core Framework, and providing material resources.

So providing tasks, talking about instructional strategies, referencing teacher-, pulling teachers back to the framework, and to the standards when the conversation starts to not be there. Providing resources like Van de Walle and things like that, you know, to keep the conversation where it should be and needs to be.

Principal Ron exemplified how he supported his teachers by researching the standards alongside a second grade meeting.

For example, second grade had a PLC. And their intent was to write a performance task on regrouping. So, we get started in there. And they start to kind of look at different tasks they could give the kids. And, and I was looking through the standards and said, 'Hey, I don't see re-grouping in here. Does anybody else see it?' And they were looking through, you know. Nobody could find the

[re]grouping. Now, they should be using place value understanding to, you know, add and subtract. Those kinds of things. But we, they need things like that, like I said, so they don't get off the ground too far.

He also described engaging in conversations after working with teachers in their classroom about instructional strategies after he taught a lesson in their classrooms – debrief on what happened, reasons for particular instructional moves, and decisions about sequencing student work.

And then we of course always need to follow up with what we did and why we did what we did. You know, and why, you know, why did I go to that kid first before the other kid? Or why do we pull that piece of work before? You know?

Finally, both Bertha and Carmen described participating in district trainings to learn more about the Common Core Standards, which attracted human resources to their PLC as evidenced by these two teachers serving as resources to other teachers at their site. Bertha and Carmen signed up for “everything we could get our hands on.” Carmen explained that,

I know Bertha and I both, we would like sign up for any professional development we could get at [the county office of education]. Anything. Like, we did math, we did science social studies. Anything related to Common Core. Because we wanted to know and have the clearest picture possible for when we start next year.

Summary of Linkage of fourth PLC.

In summary, Bertha and Carmen described connections to people, resources, and groups outside of their fourth grade PLC. The principal Ron, fifth-grade teachers Jimmy and Ben, and TOSA Kimmy each played a role in supporting this PLC with respect to mathematics and information about the CCSS Framework. Additionally,

group sought to attend any district trainings about the CCSS that they could find to learn about the Common Core Standards.

Linkage of fifth GLG.

Overall, members of the fifth-grade group described strong connections to outside resources and people (See Figure 5-1). Jimmy, Ben, and Mia each reported connections to resources outside of their GLG in addition to each other. These resources included fellow teachers like Carmen and Bertha at a nearby grade level, Principal Ron, and a TOSA math coach Kai who currently worked at the district level.

Both Ben and Jimmy described conversing with their Principal Ron about mathematics. The principal, a former mathematics middle school teacher, attended grade-level meetings and frequently answered questions about mathematics. About his principal, Ben described that:

He very much is in love with math. So he likes to try to find ways to get that into our staff meetings any way he can. Sometimes we meet after school to discuss some of these issues, how to teach math better, different concepts... A lot of teachers will go to him to ask his thoughts on math.

Jimmy also described observing his principal who would teach a lesson in his classroom. “And then he's [Principal Ron] constantly in the classroom. He came in the other day and taught a lesson in my classroom.” When Jimmy observed, he stated a focus on students when he described what he focused on during the observations. “So, I want to do, I want to get in and look at the way kids are learning, and look at how we can best impact that, you know. And so I want to look at student work.” The principal confirmed this when he noted that he often entered teachers’ classrooms to give

teachers an anchor for conversations.

Ben and Mia described conversing with Project X participants. Ben conversed with professors from Project X and the co-investigator and TOSA, Kimmy.

What's great about her [Kimmy] is that if she doesn't know the answer, she knows somebody who can get the answer. She's always made herself available for any of us that went through the Project X or Seismic. She says just call me anytime.

He also described that Kimmy often came to his classroom to teach a lesson. Mia described conversing with teachers from other sites, like Gillian, and the former co-investigator of Project X, Kimmy. “I will talk or I'll text her [Kimmy] once in a while. I've done presentations with her, or trainings with her [...] She's been a great help.”

Mia also described conversing with colleagues at her site, including teachers outside of her GLG. Most of her conversations were with Ben and Carmen because she knew that they shared values. “I could talk to both of the because our relationship just lends itself to that. And that's never really in a formal setting because I know they'll take the time to talk to me, and they value doing things like that.” She stated that conversations centered on figuring out teaching implications for particular teaching goals. “And being able to be able to kind of sit together and say, ‘Okay, we want our kids to learn this, and just feed off of each other. Oh, well that means we want to see this.’” Mia also described engaging in conversations with Ben and Carmen about pedagogy, like sources for planning lessons and questions to ask students.

And for us, like side notes, talking with Ben, talking with Carmen, saying, you know, ‘Okay this poetry version of the Common Core is really getting me. What are you using for a source? Or how are you using this, type of, like essential question driven thing? Am I

too small if I'm giving each segment a question, or do I need to be more broad?'

Mia discussed mathematics in her collaborations with Carmen, who approached mathematics in a linear fashion. This complemented Mia's facility with visual mathematical interpretations.

I have a friend Carmen at this site. She sees it very, not mathematically, but in a linear fashion. And I see it in a very visual way. And we can just kind of complement each other and go, 'Well I want them to see this.' And they go, 'Oh well that makes me think of this story problem or this context or this model.' And so we can complement each other. And then I see the math behind what my models show, and what to extract with models.

Jimmy described conversing about questioning that he could use to help students contribute to classroom discussions strategies during conversations with Carmen. "It's just discussion and talking about ideas on, on how we can present something, and questioning."

Anticipating student thinking.

Another activity described by many participants centered on anticipating student thinking. Ben described a focus on student thinking throughout his activities. He stated that he and other teachers continually try to understand mathematical concepts better, present and convey the concept to students better, and focus on understanding why in addition to how when solving mathematics tasks.

This is probably the best school I've ever been at where there's such good collaboration going on. Where the teachers are trying to figure out okay, I'm teaching this concept, help me understand it better. How can I convey to the kids better. Not just, you know, give me a work sheet, that's a good work sheet. Or, how do I do this. But really trying to figure out, I need to figure out a better

way to teach this, really going into the why, instead of just the how.

Mia described anticipating student thinking in her collaborations with colleagues. She described thinking about both student misconceptions and the concepts needed to understand an idea. “And what's needed, and what our kids need to understand. Kind of like that anticipate the misconceptions and figure out what is their prior knowledge, and how do we get them there, and what's our leading inquiry.” She also described focusing on questions to pose to students, determining when students knew particular concepts, and specific follow-up questions to pose to students to support their learning.

But definitely with people in our conversations going, ‘Here is what it says they need, what does that mean we do? What does that mean we ask them? How do I know when they know? When they're stuck, what do I do to that?’ You know, do I say, ‘here's another way,’ or ‘Here honey, do this way.’ What do I question with?

These examples show an attention to anticipating student thinking during questioning and planning practices. As mentioned previously, Jimmy focused on students during questioning and planning practices. “But it's about engaging the kids, getting them to, to really own what we're doing, you know? Not on the surface level. You need to own it. And how do we do that?”

Another connection described by members of the GLG rested in district trainings. Jimmy, Ben, and Mia each described engaging in a district-led and organized round of lesson study at the beginning of the school year. They each served as the facilitator for a group of teachers engaging in lesson study, with teachers

representing each grade level at each school in the district. For instance, Mia described facilitating lesson study with Kimmy. Mia facilitated first and second grade lesson study groups. “Kimmy gave us, the leaders, a sheet of almost like sentence starters for debriefs. And that kind of helped because it wasn't just you saying it, it was kind of like filling in the blanks of the template. So that was helpful. But yes we did do that, a few of us did.”

Mia and Ben described attending district trainings with colleagues about the Common Core Standards in their district to learn about the standards for mathematical practices. “And so some of those trainings have been very helpful [...] What do the mathematical practices look like?” Both described working with TOSA Kimmy as part of these trainings. Ben also described attending district meetings. Ben stated that he and his colleagues often engaged in planning during these district workshops, which included finding texts and researching on the internet.

So we're always trying to find resource books that are out there. But a lot of what we do is there's so much on the internet. Engage New York is a great website to go to. Almost every state has a resource that you can just go to for everything that's already out there. Performance tasks are already out there. A lot of the engage NY the lesson's are already done. So you just go through that. But there's so much out there, so you really don't have to create a whole lot on your own.

Ben also described working as a facilitator at district teacher trainings focused on better understanding the Common Core Standards – “just all the different aspects of the Common Core, like the key shifts, the performance tasks.

Linkage of Project X PLC.

The Project X PLC showed high levels of linkage. Carmen, the grade-level

leader for fourth-grade at her site, described “definitely” having connections to resources and people outside of her group. “That's probably the thing that we are most fortunate about here,” she responded.

At ten years and longer, that we've established relationships with teachers in other schools and in other districts. And so, when a need, when there's a need or there's a question, we, we all know somebody that we can reach out to that can help us with that.

Ben also echoed this sentiment when he described having connections to resources, people and groups outside of his group of teachers that he collaborates with. “This site probably has more connections than any other place I've ever been.” Mia described connections to many resources outside of her group, including Project X teachers, teachers at different sites, Kimmy, and her husband. Bertha, on the other hand, found it difficult to find others to converse with besides Carmen, Gillian, Ben, Principal Ron, and Kai. “No, just talking with different people, too. Like on campus here. I have a question and Carmen’s not here, I'll ask Ben or somebody like that. I'll ask [Principal] Ron or I'll ask Kai about... wish I could ask Kimmy but she's, you know, she's not close by.” She continued on to say that it was difficult to find others to engage in conversations. “It's hard to find somebody who gets it and can have conversations about it. So. Not really, I don't really talk to other teachers.”

Collaborating with Principal Ron.

Four of the five teachers described Principal Ron as a major resource that supported teachers’ work. Bertha asked Principal Ron questions about mathematics when she needed another perspective besides Carmen’s. Ben reported working with the principal during district workshops and helped to facilitate these workshops to

other teachers. Carmen described Principal Ron as her “go-to” when she needed to “think through a lesson for me.” “Cause I still get stuck, and I still go, 'oh crap! I can't get my way out of this one.’” Carmen described that she often conversed with her principal, who was a former mathematics teacher and “teacher at heart”. Conversing with him centered on thinking about ways to support her in teaching lessons and what to do when a student does something that she did not anticipate.

He's my go-to I guess, when you asked me like, who do I talk to. He's the person I go to when I have a question about something. And we need to like think through a lesson for me. Or if I get stuck. Cause I still get stuck, and I still go, 'oh crap! I can't get my way out of this one.' Cause a question will come up, or something. Somebody will be doing something, and I recognize that the lesson is going in a way that I wasn't prepared for. And I still get anxious....But there are times where we disagree, and we kind of will volley back and forth on, you know, our thinking behind it. And he, and usually we come to an agreement. And most times he agrees with me (laughs).

Thus, Principal Ron supported Carmen in debriefing about mathematics lessons. She continued to say that he supported conversations that she was interested in having as well as lesson study. “And he was a big supporter of just the kinds of conversations we were having and the lesson study.” Carmen also stated that she worked with Kimmy at the district level to facilitate lesson study in the beginning of the year.

Carmen also shared similar ways of approaching mathematics instruction to her principal. She noted that he “does know a lot about math” and “a lot about how kids learn math.” He is “a teacher at heart”. She stated that the two shared a belief that questioning students about what they are learning with a good problem is important for instruction. “He believes it starts with questioning. And his whole thing, which is

very is, it's in line with kind of like what I think. You know, like, give them a problem, throw it out there, see what they can do. Which I've always taught that way.” Carmen described working informally with her principal with him coming into her classroom and holding conversations about math after school. “Sometimes he'll just, you know, talk to the kids, find out what. Kind of like lesson study, you know? Like, just observe, see what they're doing. He tries to make it really non-threatening.” Although they do not always agree, they are able to find common ground.

Jimmy described his principal as an important person that contributed to collaboration in his PA PLC. Jimmy discussed how his principal supported his Jimmy’s way of working as a teacher in a number of ways, including promoting the Van de Walle text, sending links from websites, discussing teaching techniques, and teaching his class.

I feel like we've got a really strong leader here, that's really into this way of teaching. And he promotes it by, he's constantly shooting stuff. ‘Oh, check this video out!’ and, you know, ‘Here's this, here's what somebody's doing in Iowa’ and, you know, ‘Check out this lesson.’ And then he's constantly in the classroom. He came in the other day and taught a lesson in my classroom.

Thus the strong leadership of his principal helped to support this teaching in a way that aligned with Jimmy’s goals. Jimmy continued on to say that the support given by his principal would help to support lesson study activities in particular.

And so, to me that's the whole. That's lesson study. Getting in there and looking at the way kids are learning. So. I think they've done, whether it was intentional or, or unintentional, I think that they've done a good job in supporting lesson study.

When asked how specifically Jimmy saw the actions of the principal as supporting

lesson study, an activity that Jimmy described wanting to do, he noted how implementation of the Common Core aligned well with lesson study. Specifically he stated how engaging with the ideas of Common Core meant teachers collaborating and watching what their students are doing. This idea of collaboration would support a necessary component of lesson study - working with others in the process of inquiring into student thinking.

Everything that I learned in going through Project X - the way the kids are learning, and the way that we should be facilitating that learning - is embedded in Common Core. I mean, the new Common Core, and you look at some of the people that were. Wasn't Van de Walle one of the writers of the Common Core? I don't know if it was Van de Walle, or. Anyways, it flows together flawlessly. Like I said, every time we, we look at these things for Common Core, I was like, 'this is Project X, this isn't Common Core.' And so now that the district is moving, I mean, the state and the country for that matter, is moving in the direction of Common Core, and looking at digging deeper, I feel like anything that they do to support that is also going to support lesson study. Because to me, that's what it's all about. Maybe their not saying specifically five teachers create a lesson, go in and teach it, go back, debrief, go back have another teacher teach. They're not maybe saying it like that, but the collaboration, and, you know, watching each other, and all that tends to support the lesson study idea.

Thus, Jimmy saw his principal as supporting collaboration, and in particular, collaboration for lesson study.

Synergy

If you sense that the people that are leading you don't have a strong understanding of where they're going or what they want to accomplish, then how are you?

- fourth-grade teacher and mathematics coach, Carmen

Recall that *synergy* refers to the alignment of efforts of teacher community

with those of the larger community. Two of the four groups in Case 1 had low levels of integration within their own group. Thus, it is difficult to describe alignment to another group if there is no alignment within one's own group. Additionally, since the fourth grade PLC is embedded within the Project X PLC, I report synergy results with respect to each of the five participants without distinguishing between the two PLCs. For those reasons, synergy results will focus on how members of the Project X PLCs viewed the district's goals. Overall, moderate levels of synergy existed between the PLCs and the district. Before I report on synergy themes, I first report from the administrators' perspective to set the background of the institutional setting.

At the beginning of the school year, Kimmy discussed that Long Pond school district facilitated a three day intensive training for all K-12 teachers for the purpose of understanding the Common Core Standards - changes from the new standards compared to the old standards and to focus on planning units. Although typically approximately 250 people show for these trainings, this training had approximately 500 teachers in attendance. "A lot of because of Common Core. But partly because of the, it was out there that we're going to do things differently." She noted that several former Project X teachers helped facilitate the training in addition to mathematics coaches and her. She stated that they had overall positive evaluations, and noted that some teachers left the training saying in their evaluation, "I'm tired because my brain was really working today."

Now I describe themes across all participant data from Case 1. Several themes emerged, like vague and unclear goals of the district, and clear but different goals between the district and the PLC.

Vagueness.

One theme among teacher participants was a perception of vague district goals. Some teachers thought that the vagueness came from the district not knowing their own goals. For instance, Carmen said, “Honestly, I don’t think that the district knows what their goals are.” Carmen continued on to describe that they have a “broad generalized idea” of goals but have not “backwards designed” their goals to describe specifically “how it has to be laid out systematically so that teachers can evolve and develop into the kind of teacher and create the kind of classroom that we want.” Instead, the district was only “two steps in front of the teachers right now.” Bertha also agreed that the district’s goal were not clear - they are not “prepared to say this is our goal, and this is exactly what we’re going to do.” She stated that, “I don’t really know what the goals of the district [are]. I know they talk a lot about Common Core this and Common Core that. But I don’t really think that everybody up there understands.” Bertha elaborated that the general goal of the district was for teachers to better understand the Common Core Standards and learn how the new standards differed from past standards. “I think maybe their goal is to get us to understand what it [Common Core Standards] is, [...] how to look at it, and how different is it from what we have been doing.” Bertha suggested that the reason the district wanted teachers to do this was so that teachers would accept the standards. “And I think they want us to maybe understand it so that we can accept it. So that we can say, ‘Yeah, you know, this is really cool. This is a really cool way of teaching and getting things across.’” Bertha concluded by saying that the district did not know “how to get there,” and instead are “kind of just trying things, which is, you know, that’s normal.”

Jimmy also thought that the goals of the district were vague. He did not know the goals of the district. He stated that the district had intentionally “done a good job in - it’s good and bad - in not dictating, you know, what it is that we [teachers] should be doing.” He noted that instead the district left it up to the sites to determine what teachers should be doing. Jimmy said that his principal has been “a lot more flexible” than other sites, where principals have told teachers, “You will do this.” The flexibility at their site for collaboration, though, “created issues” since it is a “free-for-all”. Jimmy’s desire to “rein things in” for “a little more structure and specificity” signified a misalignment with his GLG goals to the goals of the district.

One factor that played a role in teachers’ perception of vague goals centered on the Common Core Standards. As previously mentioned, some of the teachers noted that the goal of the district was to “go in that direction” of implementing and understanding implications of the Common Core Standards. Bertha noted that she heard the district “talk a lot about Common Core this and Common Core that” without clearly communicating specific goals and how to reach those goals. She stated that the district’s goal was to have teachers understand “the philosophy behind, or the pedagogy behind the Common Core.” Carmen noted that the district did not know of their own goals in part because the Common Core Standards “came at us really kind of quickly. And we didn’t have a really strong understanding of it.” Jimmy recognized that it was a strange year for teaching and teachers due to the Common Core Standards, which he posited might be part of the reason why the district’s goals seemed vague. “I mean. This is a weird year. We keep being told that, just, this is a, you know, free year. We're going be..., we're learning ‘cause of Common Core. Um,

and so the district really hasn't been very specific about pushing stuff.” He further surmised that if the district had been specific, then there could be some similarity among goals.

But if they did, I think it would be this, you know. The ideas of Common Core that line up with Project X, that similarity. And so, if those are the goals of the district, then yeah. I think that this group, our goals line up with the district goals.

Ben, on the other hand, saw his GLG’s goals aligned with the district due to goals about lesson study. “Yes, because our district wants to continue with lesson study. And they want to use lesson study as a means to get across the Common Core concepts.” Thus Ben’s view of the goals of the district aligned to some of his GLG’s goals - for those that wanted to engage in lesson study. When asked how he got a sense of the goals of the district, he stated that it was through attending district meetings and talking to district administrators like Kimmy. “This is what the district personnel are saying. Kimmy is heading a lot of this up. So this is her goal.”

Clear But Different Goals.

Unlike reporting that the district’s goals were vague or that they did not align with their own groups’ goals, Mia reported that her GLG’s goals did not align with the goals of the district. She stated that district’s goals of meeting standards or performing well on tests did not carry weight in terms of indicating students’ progress. “Those goals of meeting that standard or performing well on that test, it didn’t mean anything. But some, some, not all, in the district don’t really see that. Or they’re only seeing a report or data table or whatnot. Or they’re having to appease their superiors.” Mia saw some people at the district level as “assessment driven” in part because “it’s how they

get their money, it's how they rank." She noted that even though the district had said "it's transition year" where teachers "have the support of admin" who are saying "this is your year. Delve in. Find out your pacing, what you need to strengthen, where it takes you", the district is still "coming in to look for certain curriculum out because that means we're teaching well." Hence though Mia perceived support from the district in coming to understand the new set of standards, she stated that the district's goals were not aligned with her PLC goals in part due to being assessment driven and assessing whether a teacher teaches well based on the presence of a curriculum.

Bertha described a goal shared by Carmen and herself that she did not see as supported by the district. Bertha valued being able to observe other teachers. "I think that viewing other teachers is super valuable. And I wish that the district - and maybe they do - I wish that they would see it in that way." She further explicated her position when she said,

I've always said that, you know, if you want somebody to buy into it, my God, go look at somebody who's like really awesome so they can be like mesmerized. Or they can be like, Oh my God I don't do that. How did you get your kids to say or do that?

This data targets the three themes (vagueness, dealing with the Common Core, and differing goals). Bertha's uncertainty about whether the district valued teachers viewing other teachers like she did, Bertha's values about professional inquiry to learn more about the Common Core, and Bertha's view of a lack of alignment of collaboration goals between her groups and the district. It is important to note that Kimmy, a district administrator, named principals as willing to cover a teacher's class at their site while they work with another teacher. Also, Principal Ron stated that his site supported

teachers' collaboration and that he would teach a class.

Carmen noted that the district must not be in complete support of teacher collaboration if they do not continue to support successful efforts. She thought that the district no longer supported efforts like lesson study because they did not appear to support teachers' work after the grant ended.

We've had these two grants. We've had great success with these two grants. And they let the grants go because they weren't funding them. So there was no reason to block it. Like who's gonna block it if you've been given all this money to develop as teachers? But I don't feel like the district was ever in complete support of it either. It's like, 'This is really great. And you're doing some really great stuff. Oh, but wait. You want me to pay for it now? Oh no, we don't, we don't agree with it' kind of mentality [...] Nobody's taking a position on lesson study. It's like, 'Oh it's really great, and we really like it. If you want to do it, you can do it. But we're not gonna force you to do it.' Or, 'We're not gonna make this the goal of our district.'

She described that support from the district would look like teachers investing resources to develop their knowledge and skill as a teacher.

Whether it's somebody has to decide, like, hey, lesson study is important. So we're going to give it the credence, the time, the resources that it really needs to develop. And we're gonna foot the bill because we are investing. Instead of buying curriculum, we're gonna invest in our teachers. But until they decide to do that, (pause) not a lot's gonna change.

Summary of synergy.

Two themes in the data suggest low levels of synergy between formal GLG's and the district, and moderate levels between the PLCs and the district. First, teacher participants described that the district's goals were not clear. Carmen, Bertha, and Jimmy stated that the goals of the district were not clearly stated, which made it

challenging for any of the four groups to align their goals with the district. Some of the lack of clarity resulted from the district trying to understand the Common Core Standards and their implications for teachers.

At the fourth-grade level, Carmen and Bertha asserted that their GLG's goals were not aligned with the goals of the district since the goals of the district were not clear. This left little room for aligning an already disparate set of goals. As Carmen wondered, "If you sense that the people that are leading you don't have a strong understanding of where they're going or what they want to accomplish, then how are you?" Since the district did not make clear what their method for attaining their goals were, there exists a lack of alignment of the efforts of their GLG to the efforts of the district and hence low synergy.

At the fifth-grade level, there was not consensus on whether their grade level goals aligned with the district's goals. Jimmy saw the district's goals as vague, Ben saw them as aligning with his GLG, and Mia saw them as clear yet not aligning with her GLG. This brings us to the second theme, clear but non-aligning goals, that suggested a lack of synergy. Mia described that the district's goals were clear but that they did not align with collaboration goals of her affiliated groups. She saw the district as assessment driven that still sought old measures of success for teachers, like whether teachers utilized certain curriculum, even though they stated that it was a transition year for teachers. Bertha highlighted her view of the district as not supporting teachers observing other teachers.

With respect to the PA PLC group at the site, some thought the goals aligned, like Jimmy and Ben, while others did not address the possibility. This suggests

moderate levels of synergy for the PLCs.

Case 2

I now turn to a middle school in Sun Valley school district. Recall as described in resources that Sun Valley created a district-wide PLCs, with teacher representatives from each grade level and their principal joining other teachers and principals from the district for training at the district office. Sun Valley school district also began supporting select teachers who wrote assessments for the whole district the summer of 2013, before interviews for this study were collected. Case 2 involved a site with three Project X participants along with their principal. Each teacher represents one of three grade levels – 6 , 7 , and 8 – with the sixth- and seventh-grade teacher both mathematics teachers, and the eighth-grade teacher a resource specialist program (RSP) teacher. Each reported working mainly with their fellow content teachers in the same grade. Having examined Case 1 in detail due to the high number of teacher participants and reported support, I now restrict the reporting of analyses to be more broad. Within each of integration, linkage, and synergy, I report on results that cut across each of the participants’ content groups.

It is important to note Nancy’s situation during her current year of teaching. Nancy’s sixth grade team of teachers was new to her site starting at the beginning of the current school year. Nancy joined them midway through the school year in January due to medical leave from the start of the school year. These teachers worked “quite intensely together” without Nancy for four months and described them as having “melded” together using their particular strengths. Nancy stated that the leader of their group was interested in transitioning to administration one day, so it was important

that she play “some of those administrative roles”, and ended up being the lead teacher for their group. “She’s all about being very positive and affirmative,” which did not align with Nancy’s norm of conversing to “say it like it is.” Nancy also described herself as opinionated, and that she sometimes did not agree with her colleagues. In fact, she described writing her own curriculum based on analyzing assessments to determine where the majority of her students struggled. She wrote her own spiral review, homework, and tests. About what her colleagues did in terms of their own approach to instruction, Nancy said concluded, “I don’t know what they’re doing.”

I now describe themes within this case, with individual teachers representing their respective formally arranged group. After reporting themes, I will make the case for a level of integration with respect to each of the three groups.

Integration

Alignment of visions of effective teaching.

Alignment of views of effective teaching varied, with alignment among Anita’s ELA GLG but misalignment with both Kamille and Nancy’s content group. Anita, Kamille, and Nancy all focused on moving the students’ thinking forward, monitoring where students were in their understanding, and creating good tasks (either ‘discovery’ type lessons like in Kamille’s case or ones that are well researched like Nancy described). I now describe if their views aligned within their respective groups.

Eighth grade RSP Anita.

Anita described that the goals of her eighth grade language arts group were to provide learning to every student so that each received “the same content in the end” and that they were all “on the same page”. They engaged in similar activities together.

“There’s a lot more planning together, and a lot more looking at assessments together, looking at how the kids did. Like more reflection.” She found the collaboration more productive this year compared to last year in part because “it applies directly to the classroom.” Last year she felt as if the activities they were told to do was to “fill up time” - such as analyzing data. “This year, we get to kind of figure out how we’re going to get to where we need to get. We look at the assessments, and kind of try to plan backwards.” When asked about what effective teaching meant to her, she described that it meant a situation where students were learning, could communicate their learning, and each have the same opportunity to learn regardless of ability.

The students are learning something, and that they’re able to explain back to you what they’ve learned. And that everyone has the same opportunity. That everyone’s getting it, whether they’re high or whether they’re low. They’re still coming away with something. And that some kids who are maybe higher can go a little bit farther, and the kids that are lower, they’re getting something and then we’ll just keep building on that.

When asked whether Anita and her colleagues shared values on what constituted effective teaching, she responded with, “Yes, I would definitely say so.” Anita described her goals as helping students to “think how things, why things were the way they are, and not just memorizing rules.”

One of the reasons Anita reported not working with the mathematics teacher at her site and instead working with the ELA teachers centered on Anita’s belief that the mathematics teacher did not see Anita as bringing additional value to his work. Anita stated that he did not see her “as an equal person” and consequently did not usually include her. This stood in contrast to how Anita described working with the language

arts teachers in the eighth grade. She described that the group of language arts teachers worked well together and included her in everything they do. Being a special education teacher who focuses on ELA (and not Math and ELA like the previous year) she described this group as teachers who “all work well together” and who included her in everything they do. This inclusion to the ELA group stands in contrast to not being valued as a professional to work with the mathematics teacher.

Seventh grade Kamille.

There was little evidence on the goals and values of Kamille’s fellow seventh grade colleagues. Though their definitions of effective teaching varied, Kamille stated that they shared similar goals, with the main goal being “we want the kids to succeed.” When asked if the teachers in her grade level shared values about what constituted effective teaching, Kamille responded by saying no, although she has tried. “We’ve tried, let’s put it that way. And the definitions differ. And what we perceive is, really is not. And sometimes you just can’t tell a blind man you’re blind until they see it in a different way. I mean, I used to think I taught conceptually.”

Kamille described her own value in teaching by using guided discovery to introduce ideas rather than using direct instruction to tell students how to perform calculations. When describing a recent lesson she planned with math coaches, she highlighted guided discovery over telling and practicing. “Both lessons were not only discovery for the kids, but a lot of guided questioning. As opposed to sitting there and going, here’s step one, now you guys practice it. Here’s step two, now you guys practice it.” She stated that effective teaching requires students to think, which could make them uncomfortable. “Requiring them to see deeply, which means they’re going

to have to go through problems and think about them, as opposed to just saying, ‘this is how you do it.’” She noted that learning should first start with students discovering an idea, then look for patterns and algorithms, and finally practiced and refined. “I think a lot of it is student discovery, and after they start to discover it, recognize those patterns, then the algorithms, as they start to discover them, can be introduced, and then practiced and refined.” She noted an appreciation for a balance between direct instruction and discovery, with discovery needing to come before direct instruction.

Sixth grade Nancy.

It was more difficult to ascertain whether Nancy believed that her group’s goals aligned. On the one hand, Nancy said that she was “positive” that they aligned since together they create interventions for students. Yet she continued to state that she believed it was “just ridiculous how we do it [interventions].” She also stated that she was not sure whether her group’s goals aligned with Project X’s goals since “we never get a chance to talk about what we’re teaching, or how we’re teaching it.”

Nancy’s views on effective teaching centered on being aware of each student’s learning progress by monitoring and adjusting instruction. She emphasized teachers knowing students’ prior knowledge before instruction, emerging understandings during instruction, and how to back up if the students were “not really with you.” “Not just backing up, but knowing what am I going to do about this. And that takes time.” Some of the practices she wanted students to engage in involved referring back to what they already know, searching for multiple solution paths, checking their answers, asking under what conditions a solution holds, and realizing correct solution paths. She summarized by saying,

To me, effective teaching is really having like an arsenal of all these different approaches and being aware of how do you get the kids to realize the different approaches and to take personal responsibility for the one that works for them.

Principal Kate stated that her view of effective teaching grew and changed recently to include a greater appreciation for “inductive” lessons. These were lessons that allowed students to discover and construct their own understandings rather than being told what to think by teachers.

Thus, Anita described high levels of integration with her ELA group of teachers, while Kamille and Nancy described low levels of integration. Anita, Kamille, and Nancy each described a similar view of effective teaching as one that centered on understanding the conceptions students bring to each lesson, how each student understood the new topics addressed during instruction, and what to do to help those students not understanding to learn the lesson.

Similar goals, different paths.

Another theme in the data that helped elicit levels of integration at this site centered on teachers’ recognition of having different paths or methods of reaching similar goals. Both Kamille and Nancy gave evidence of this theme.

Seventh-grade Kamille.

Kamille, like Mia, recognized a distinction between having similar goals versus having similar ways of reaching those goals. She noted that, “On Kamille’s grade level team, the ways in which teachers helped students to achieve a deep understanding varied among them.

We want the kids to be successful. Project X, we want them to be successful with a deep understanding. How we get there is very different. We think we're giving them a deep understanding, but we're really not. That's the problem. And that's where we're not aligned.

Kamille expressed that due to this reason, the goals of her content group were not aligned.

Sixth-grade Nancy.

Nancy described one of her colleagues' ways of teaching as frequently involving PowerPoint presentations for students. Nancy did not find these to be a particularly useful tool for teaching. This was because there was limited time for students to write things down, and a lack of record of things discussed in class, which could prove problematic when their parents ask what the student learned that day. Nancy described another teacher in her group as one who taught "kind of to the bottom" student understanding, and not challenging students who needed more challenge. Nancy speculated that the teacher did this because the teacher formally taught elementary students in addition to seventh grade students. "She feels like she's got so many kids struggling, she breaks everything down into very basic, which is great." She continued to express worry about whether these students would be equipped to meet seventh grade requirements "when you have simplified it overly too much." Thus, Nancy expressed a misalignment with two members of her group with respect to the method that these teachers used to reach their instructional goals.

Finally, Nancy's data suggested moderate levels of integration when she agreed that her group's goals aligned but then expressed that she did not agree with the

way that her group handled intervention, for example. Nancy stated that she was positive that the goals of her group aligned, but also gave evidence of not agreeing with prioritizing them over other goals and activities. She explained that one of the main goals was to use formative assessments to help guide interventions.

Do you mean like the group at my site? Yeah, yeah. I'm positive about that. We do intervention, and so after a district assessment, we pulled the kids that have failed. We all decided which part of the test did they fail, then that's the one we were gonna address. And so there's a lot of cohesion there.

Yet Nancy did not agree with the way the intervention was done, like intervening on a topic two weeks prior that did not align with the content students were currently learning. “To me, it seems more logical that you'd be intervening. Like you'd be taking little formative assessments right now on geometry and supporting them. Because the classroom instruction's supporting that.” Thus, though overarching goals aligned in some ways, Nancy did not always agree with how their group addressed issues of intervention.

Lack of agreement on how to spend collaboration.

A theme that appeared in the data for Nancy centered on an apparent lack of agreement on how she and her colleagues spent their collaborative time. Before I describe the theme of a lack of agreement on how to spend time, I first describe background information about the composition of Nancy's current content group.

One of the ways that Nancy's goals and values did not align with the goals and values of those in her content group rested in the lack of agreement on how to spend time. She expressed being unhappy with the current direction that her group was

heading, noting that they did not collaborate on instruction. She stated that they were “forced into” their team due to district changes in teacher locations, like teachers leaving the current site and the new teachers leaving their former sites. Nancy stated that there was “never have time for teachers to really share what worked” and wished that colleagues would converse about instruction - “break down” the content and “really talk about how are you teaching this?” rather than discuss formative assessments and pacing of content. Nancy described not having reached a point with her colleagues’ collaborative meeting time where they could share insights on instruction. She described wanting to be at a place “where we are all doing the same thing year after year so we can finally talk about how we are teaching, or what we are teaching.” Yet despite these explicit goals, discussing how to teach content with her colleagues “just has not happened.”

Further evidence in the data that affirmed Nancy’s lack of agreement on how her group should spend time surrounded Nancy referring to herself as “not a team player”. She then clarified that it was due to her opinionated personality and dislike for a lack of agreement on how her colleagues should spend their time. Whenever Nancy did not agree with other teachers on how to spend time, she would dislike collaborating with others and preferred to work on her own.

Shouldn't say I'm not a team player. I don't mind working with other people. But, I'm just really opinionated. And that's not really, you know, that's not really handled very well. So. I don't know. I don't like a lot of wasted time. And when you get a bunch of teachers in the same room, I want the time to be utilized most efficiently. Oftentimes, it's about 50% of the time is efficient. The

rest of your time you're like, 'Oh my gosh. Just let me go back to my room. I'll figure this out on my own.'

Nancy described being supportive of one another in their group but did not have cohesiveness and did not “necessarily like each other a whole lot on a personal level.”

Summary of integration at Case 2.

Several themes emerged from applying the integration framework to this case. First, all three teachers shared similar views on effective teaching among themselves but this was not true within each participants' respective group. Whereas Anita described an alignment of goals and views on effective teaching within her eighth-grade ELA group, Kamille reported that there was no alignment of effective teaching in her mathematics group. Nancy reported explicitly that goals aligned and but implicitly suggested that they did not always align. Thus, while Anita reported high levels of integration with colleagues in her eighth-grade ELA group, Kamille and Nancy reported low levels of integration.

Another integration theme centered on similar goals but different paths to reach those goals. Both Kamille and Nancy gave evidence that “how we get there is very different” among members of their groups. Thus, this serves to also suggest low levels of integration for Kamille and Nancy's group. A final integration theme centered on the lack of agreement on how to spend time. Nancy expressed that she was unhappy with how her group members often spent their time, noticing a lack of discussion about instruction and how each teacher teaches particular topics. This also serves to suggest low levels of integration for Nancy's group.

Linkage

Overall, participants reported connections, both particular and general ones, to people outside of their content group (See Figure 5-2).

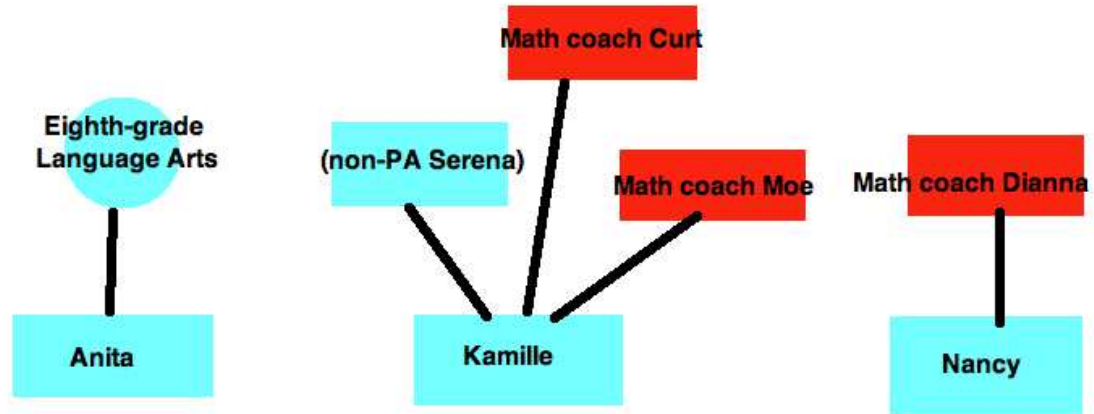


Figure 5-2. Linkage graph for Case 2, with eighth-grade RSP group, non-PA seventh-grade teacher Serena, and mathematics coaches.

RSP teacher Anita described having connections to teachers at her own site and other sites. Anita and her colleagues “have more connections, have reached out to like other teachers that teach the same content at different sites and gotten resources.” She referred to connections in general and did not specify any names of teachers that she worked with. Anita often observed other teachers in part because of the nature of an RSP teacher. These activities served as ways for Anita to learn different strategies and teaching styles, or human resources, from these linkages.

I’m in enough classrooms anyways that I see so many different teaching styles, and different things that I pick up things from people all over the place. So it’s different for me. I’m exposed to it every day. And every year usually [it is a] different teacher.

Seventh grade mathematics teacher Kamille described mostly working with grade level content teachers and “sporadically” working with Project X colleagues.

She described working with another seventh grade teacher, Serena, who served as the math representative for the Common Core. This relationship served to help the group in “keeping up with Common Core.” Kamille’s group attracted human resources in the form of knowledge about the Common Core implementation from Serena. Kamille also described working with two mathematics coaches, Curt and Moe, who helped her learn from co-teaching and debriefing a co-planned mathematics lesson. When she detailed her work with the math coaches, Kamille said that they planned a couple of lessons together, observed one another teach the lesson (sometimes one of the teachers taught it, and other times a coach taught the lesson), and engaged in follow-up discussions on whether they had met the objective. These mathematics coaches attracted human resources to Kamille.

Sixth grade mathematics teacher Nancy described working with the mathematics coach, Dianna. The math coach Dianna often visited her site when they had a release day to help teachers “come to understand on your own, not telling you, but helping you think about this. She’s a great questioner, that sort of thing.” The interview with math coach Dianna confirmed that she worked at Nancy’s middle school one day each week. Thus, Nancy’s relationship with math coach Dianna, which started during Project X when Dianna was the math coach for Nancy’s lesson study group, served as a human resource. Due in part to a medical leave of absence for the first four months of the school year, Nancy described few other teachers besides these teachers.

Principal Kate stated that she described working with math coaches in her district and the teachers at her site. Principal Kate stated that she supported teachers at

the site by gathering material resources, modeling strategies for teaching mathematics, and being available for teachers. Principal Kate named Dianna as one of the mathematics coaches that she worked with. Dianna also stated in her interview that she worked at their middle school and was on site on the same day each week. The principal described feeling as if she were part of each PLC. “I see myself as a part of the greater PLC. I see myself as, you know, kind of setting the vision, but yet certainly not alone.”

Another claim made by the principal’s use of resources for teachers centered on her views of curricular material resources. Principal Kate stated that she was doubtful that teachers would rely fully on a textbook in the future. Citing some textbook companies with “canned lessons” of standards that did not always seem to match the lesson, she was not convinced that she wanted educators to rely heavily on a textbook.

Why would we want to go to just a math book, and just have that be our, our guide? Why? Why would we do that? Because we’re giving away our judgment. We’re giving away our professional ability to collaborate and make something better.

She saw teachers potentially “stifling your own thinking and your team’s own capabilities” when relying to heavily on a material resource like a textbook. She qualified, though, that there may be good textbooks that she did not know about.

Summary.

Anita described general connections and resources to people outside of her group to attract material resources for instruction and also human resources like knowledge of strategies and teaching styles from observing other teachers’

classrooms. Kamille's relationships with Serena and mathematics coaches attracted human resources of knowledge about the implementation of the Common Core Standards and support on teaching mathematics. Nancy found curricular resources online to research and plan lessons and discussed issues related to teaching mathematics with math coach Dianna.

Synergy

Varying levels of alignment of group and district goals.

Each of the three teachers described varying levels of alignment of their content group's goals and administration goals, with Anita reporting moderate alignment and Kamille and Nancy reporting low levels of alignment.

Eighth grade Anita.

With respect to site administration, Anita reported that the administration at her site was supportive of lesson study. Anita was also encouraged that her administration supported her group in observing other teachers' classroom, stating that they would find the material resources, like money for a substitute teacher, to cover Anita's class if Anita wanted to observe another teacher's classroom. "I've heard her, our principal say before if you guys want to watch someone, let us know. And they've encouraged people to go watch certain people and their strategy." Anita believed that her principal was "totally supportive" of Anita doing lesson study. The site administration "thought it [lesson study] was great." "They loved it when we'd do that. They would come in and watch." This evidence suggests high levels of synergy between Anita's group and the site administration since both her group and the site

administration stated support for observing other teachers and teachers engaging in lesson study.

With respect to district administration, Anita stated that the district and her colleagues shared the same goal of wanting students to learn but recognized that each had different ways of reaching the goals. “I think we all have very similar goals. Not always the way we get there. But, but I think it’s, yeah. We all want the kids to learn the same things.” The theme of ‘same goals different paths’ resurfaces here in Anita’s data. Anita described two goals, one on Common Core, and the other on all students participating and learning the content. She viewed the district as having the goal of “to do Common Core.” Staff developments and feedback from observations helped to communicate the goals of the district, which centered on having “all kids engaged [and] participating” in learning the same content. This evidence suggests moderate synergy. More evidence about specifics of the district’s goals would be needed to make a stronger claim of levels of synergy.

Seventh-grade Kamille.

With respect to site administration, Kamille stated that her administration did not understand the way that she taught students – “she doesn’t understand what I do” – with Kamille often wondering what the administration was thinking. Kamille observed mathematics teachers questioning in the same way that she questioned her students, which was “a lot more received” than when she did it. Kamille also described a large difference between what should be taught and what is taught, and what the district expects and what she thinks teachers should do. “It’s already been told to me there’s a huge misunderstanding between what should be and what is. What the district expects

and what should be. And so there's like a caught-in-the-middle ground." Thus, Kamille acknowledged a difference in how the site administration received her teaching compared to how Kamille viewed her teaching. This suggests a lack of communication between Kamille's group and principal expectations.

Kamille stated that she did not believe lesson study "would be really welcomed from admin from me" because the principal "doesn't understand what I do." She reasoned that if there been more teachers at her site familiar with lesson study, then it would be easier to do a lesson study. Instead she believed that "being the only soldier here saying, 'hey I'd like to take a day off to go do a lesson study'" made it more difficult for the administration to support her in a release day. Kamille stated that she wanted a grant that would teach administrators about what she had learned so that they could better support the efforts. Thus, this suggests low synergy, or low levels of alignment among her group's goals and the goals of the site.

Kamille countered this disjoint between the administration's perspective and the mathematics coaches' perspective with a positive experience from her site administration observing her classroom. When the administration saw a lesson co-planned and taught by Kamille and a mathematics coach, they saw it as a positive form of instruction. Kamille stated that she liked how the administration could see a "different form of instruction" and "a different way to do it" other than direct instruction, which is what Kamille thought the site and district administrators wanted. Thus, this evidence serves as some evidence for the potential of alignment of her group's goals to the administration.

With respect to the district administration, Kamille stated that she was not sure the district knew what they wanted from teachers. Kamille noted that although the district wanted students to do well on standardized tests and understand the content, she did not believe that the expectations set by the district would result in deep student understanding.

I know they want the kids to do well on standardized tests. And they want the kids to do well. And I know they say they want the deep understanding. But then what's expected is completely opposite. Because what they expect to see won't yield deep understanding. And that's the frustrating part for me. We all want the kids to do well.

Kamille described a difference between what the district wanted to happen in instruction and what actually happened. This is similar to the disjoint in expectations she described between teachers in her group and her site administration when she noted that there is a gap between “what should be and what is, what the district expects and what should be.” Kamille described this feeling as a “caught-in-the-middle ground.”

Kamille exemplified a difference between her group's expectations and the expectations of the district administration. Kamille stated that the administration's idea about meeting objectives during a lesson centered on whether a teacher completed the whole lesson. “If you don't finish [the lesson], the thought is you didn't meet the objective.” This stood in contrast to how Kamille saw the objective as being met: “But they did, they just didn't get to all the end, cause they only got through 3 or 4 problems.” She stated that both she and the mathematics coach teaching with her agreed that they had met their objective since students were analyzing and justifying

their thinking, and clarifying the misconception that was related to the main mathematical idea. The lesson did not have to be followed exactly for it to be a successful lesson in Kamille's eyes. Thus, Kamille saw the administration not believe that the teachers met an objective because not all the problems were completed, whereas Kamille and the mathematics coach believed that they met the objective. Even though the entire lesson was not enacted by the mathematics coach, who was teaching the lesson, he was able to "go a little bit deeper into something to clarify some misconceptions," which they saw as successful. This suggests weak synergy between her group and the district.

Sixth-grade Nancy.

Nancy reported that she did not know the district's goals. "I don't really know what the district's goals are, actually." She believed that the district may be "biting off the whole chunk in one mouthful." Though she noted the leadership of the district was "moving in a positive direction" with respect to Common Core Standards, she hesitated to say that she fully supported district plans. This was mostly due to the fact that she was not involved in Common Core meetings and was not updated by the teacher that attended these meetings. She stated that if she were the representing teacher for the Common Core meetings for her site, she would tell the district that what they are currently doing "is not benefiting the kids at all."

Nancy's data also suggested that teachers were not supported with enough collaboration time to design lessons and discuss instruction. Nancy stated that teachers "just don't even have the time" to design lessons the way she would want to, resulting in Nancy feeling pressed for time during instruction. Nancy noted that the district gave

teachers unit planning organizers so that teachers could understand the content that students need to know at the end of a unit. Since Nancy did not write these unit planner organizers, she stated that she was “not even sure that’s really what the Common Core is talking about,” suggesting a lack of trust in the way that the district supported teachers in understanding the new standards and their implications. Nancy stated that she was “just kind of having to go along right now” because she missed the first part of the school year.

Nancy believed that lesson study could improve what the district has done since “one person planning can only be improved if several people are helping.” She concluded that lesson study would help teachers “break down common core and figure out what we’re supposed to be teaching,” which was not currently occurring at her site. Due to the lack of clarity on the district’s direction, her skepticism about the nature of unit planning organizers created by other teachers in the district and given to her by the district, the lack of time to design instruction, and her desire to engage in lesson study to improve on what was currently happening in the district, Nancy’s data suggests low levels of alignment between her group and the district.

Principal Kate saw her role as principal as being an instructional leader on “a two way street” of professional development who helps to set the vision for instruction. Principal Kate held the perspective that teachers were equally as important as the principal. “They’re the ones dealing with the students. They’re the ones dealing with their teams. They’re the ones dealing with the new standards.” Having “conduits” where “teachers are able to tell you what they need, what they need more support with” was one of the themes.

To help communicate her vision, serve as a human resource, and maintain a “two way street,” Principal Kate described a number of ways of interacting with teachers. First, she described working closely with the PLC leadership team, which comprised a teacher from each content team as well as special education teachers, to identify instructional priorities. They served as a “sounding board” and a “cabinet” of teachers to decide what would occur over the year with respect to instruction. “We talk about where we are, where do we want to be, how are we going to get there, and then we look into the months and then we think about what could be done by the end.” She described checking in with the leadership team to see if she pushed an idea too much - “is that too much?”. With respect to the amount of autonomy teachers have over their collaboration versus the amount of involvement administrators have, Principal Kate stated that it’s “always a struggle”. “I couldn’t say, ‘today you need to do this in your PLC. That is not something that I would think that I could do.’” She noted that the majority of teachers use their PLC time wisely.

Second, Principal Kate described guiding professional developments through regular monthly meetings and also on half or full release days. Principal Kate liked to give teachers time for positive collaboration experience. Third, Principal Kate stated that most teachers turn in a short set of notes after each PLC regarding the topic of discussions. Principal Kate always looked at the part on the bottom, which asked each group, “How can admin help you?” She said that she liked to respond quickly “to show that I support what they’re doing,” like if they hoped to purchase material resources like manipulatives, wondered if something was allowed, or need release time for development.

Finally, Principal Kate circulated weekly newsletters contained “news you can use”, and focused on discussing productive PLC work (“I’ll shout out a team for an achievement that they’ve had”) or suggesting teachers to look at the new standards. Principal Kate noted that she could not direct teachers about what to do because of “contractual barriers”, which stated that PLC should address four main questions, be teacher-driven, and work in concert with administration. She noted that she could give teachers a “heads up, the ‘hey it seems like it would be a good idea to be doing this.” About this communication, Principal Kate said that teachers wanted it to be successful. She also mentioned having personal conversations with teachers as a way to convey her goals for their collaboration.

With respect to her goals for teacher collaboration at the site, Principal Kate described her main overarching goal to be improving student learning for “every single individual,” where learning implied knowing content and habits of mind. This goal aligned with the goals that her teachers shared about effective teaching where each student participated in their own learning. Principal Kate also wanted teachers at her site to learn how to identify how their students are learning. She described general goals for the school year, but also recorded that she “needed to listen” to teachers, again supporting the idea of her “two way street” method of professional development. Principal Kate noted how last year she had to adjust her goals because teachers were exhausted and stressed; for instance, her goal of working on creating and using common formative assessment data during teacher collaborations. She said that she had to “dial this back”, though, when trying to engage teachers in this analysis the last year.

Principal Kate described that her views of effective teaching grew over the last few years. “The Project X grant has actually been a part of that, as have the Common Core Standards.” For many years, she believed that good teaching involved planning activities, questioning students, and understanding of student thinking. She described effective teaching as one where: teachers had an objective of what students should be able to do at the end of each lesson, students were engaged and held accountable for the content, teachers were aware of where students were, teachers adjusted instruction based on where students are, and finally, teachers gave clear and immediate feedback. Principal Kate’s new conception on effective teaching differed by what she called teaching “inductively.” Teaching inductively meant teachers allowing students to have a discovery process. This often meant leading students to “construct their understanding” rather than be told ideas directly by teachers. Principal Kate noted that this way of thinking about teaching was not in opposition to her original ideas.

It’s difficult sometimes for people to understand that you can teach something inductively and you can still have an objective. You still know what you want the students to know and be able to do by the end of the lesson. It’s just that you’re going to guide them there in discovering it.

For instance, a teacher must “allow for so much more misunderstanding than a teacher might normally be comfortable with” when students worked to discover a challenging idea. She noted that as an administrator, she had to learn to “sit longer than I would normally want to” with student errors and thought processes that were not immediately correct when she was in a teacher’s classroom. Principal Kate stated that she learned from her trained teachers who used inquiry to guide student learning.

“That’s a really awesome thing, when you see it being done effectively.” She concluded that questions she asked herself about “inductive” instruction included “how does a teacher facilitate those groups, how do you even like how do you match your kids together, how do you pose your questions, how do you, what sorts of activities did you give them.”

Principal Kate summarized her vision for her teachers as the following:

I feel like my vision comes from my, from my teachers, particularly from my leadership team, along with, you know, what I learn from, you know, my administrator meetings or things that I read or what have you. Again, two way street.

Principal Kate described that she supported lesson study and teacher collaboration in general. The current setting of the district as one where teacher collaboration was needed. The current new set of standards did not changed *how* she viewed teacher collaboration but rather changed *what* they needed to collaborate around, such as the topics and activities of teachers. She stated that teachers had to focus more on “the what” that they teach, in other words, to figure out what success looks like and how to teach habits of mind. “If anything, I would just say that the Common Core has intensified the need for teacher collaboration.” She stated that she has always had strong views on teacher collaboration, and that it is “embedded in the culture in our district.” She stated that she believes teachers need “even more time to do it than they needed before.” The challenges surrounded both finding the funding for time for teachers to collaborate and the “right structure” to the time.

Principal Kate concluded the interview by stating that the need for teacher collaboration was the greatest it has ever been because “we’re not all so comfortable

with those standards anymore. And so to get together and be able to discuss, you know, something different. What does this mean to us? I think that's essential.”

Summary of synergy at Case 2.

This site reported weak to moderate levels of alignment between their respective formally arranged content groups and the district. Anita described that her group and the district share a general goal of wanting students engaged and participating in learning the same content despite the district's different way of reaching their goal. Anita saw her principal as supportive of her group's efforts to observe other teachers' classrooms and engage in lesson study, thus suggesting moderate levels of synergy. Kamille and Nancy, on the other hand, did not see their respective groups' as aligning with the principal or the district. Kamille did not feel as if the site administration understood her style of teaching. Additionally, Kamille was not clear about what the goals of the district were besides doing well on standardized tests and understanding the content. This misalignment on values in what helped to create good instruction for students frustrated Kamille, and leads to low synergy. Though Nancy was optimistic that the district was “moving in a positive direction”, she expressed that the district might be “biting off the whole chunk in one mouthful” with respect to implementing Common Core Standards. Her group thus demonstrated low synergy due to her skepticism with the way the district supported teachers with the implementation of the new standards.

Interestingly, there was not consensus on how each of these three teachers saw their principal with respect to lesson study. Anita perceived her principal as “totally supportive” of lesson study, whereas Kamille said that it would be difficult to get

release time to do lesson study since she was one of the “only soldiers” of lesson study at her site. Nancy’s data was less clear: she thought that the district was going in the right direction but was also unclear on their goals. Nancy stated that her principal supported her and had confidence in her teaching abilities. Thus, whereas Anita described alignment between her group and the principal with respect to engaging in lesson study, Kamille’s data suggested the opposite, that the principal would be reticent in supporting lesson study with Kamille’s group. Nancy’s perception of support from the principal landed somewhere in the middle of Anita and Kamille. Principal Kate stated that she was very supported of lesson study and collaborative efforts of the teachers in general.

Summary of Case 2

Summary of eighth-grade ELA group.

Anita described an alignment of goals and views on effective teaching within her eighth grade ELA group Anita described general connections and resources to people outside of her group to attract material resources for instruction and also human resources like knowledge of strategies and teaching styles from observing other teachers’ classrooms. Anita described that her group and the district share a general goal of wanting students engaged and participating in learning the same content despite the district’s different way of reaching their goal. Anita saw her principal as supportive of her group’s efforts to observe other teachers’ classrooms and engage in lesson study, thus suggesting moderate levels of synergy.

Summary of seventh-grade mathematics group.

Kamille reported that there was no alignment of effective teaching in her mathematics group. Kamille's relationships with Serena and mathematics coaches attracted human resources of knowledge about the implementation of the Common Core Standards and support on teaching mathematics. Kamille did not feel as if the site administration understood her style of teaching. Additionally, Kamille was not clear about what the goals of the district were besides doing well on standardized tests and understanding the content. This misalignment on values in what helped to create good instruction for students frustrated Kamille, and leads to low synergy.

Summary of sixth-grade mathematics group.

With respect to integration of Nancy's group, Nancy reported explicitly that goals aligned and but implicitly suggested that they did not always align. Additionally, Nancy expressed that she was unhappy with how her group members often spent their time, noticing a lack of discussion about instruction and how each teacher teaches particular topics. This also serves to suggest low levels of integration for Nancy's group. With respect to linkage, Nancy found curricular resources online to research and plan lessons and discussed issues related to teaching mathematics with math coach Dianna. With respect to synergy, Nancy expressed that the district might be "biting off the whole chunk in one mouthful" with respect to implementing Common Core Standards, though was optimistic that the district was "moving in a positive direction". Her group thus demonstrated low synergy due to her skepticism with the way the district supported teachers with the implementation of the new standards.

Case 3

Integration

Lack of collaboration.

Tonya described not meeting with teachers to discuss mathematics content or issues of instruction. Tonya described herself as “an island unto myself” and “in a vacuum”. Her site discontinued PLCs for the current school year due to funding issues. About her fellow seventh grade teacher and only other teacher who taught seventh grad mathematics, she noted that, “We don’t even teach at all anywhere close to what each other teaches. We share stuff, like, ‘Hey I found this here,’ but for the most part we just do not plan together.” Tonya valued working with other teachers to create and plan lessons, which created a sense of frustration about her situation as a teacher at her site.

Tonya posited that the reason her other seventh grade teacher did not want to collaborate was a sense that the work on creating lessons would be wasted.

It's like my other seventh grade teacher. He doesn't want to. He's just waiting for other people to come up with good stuff. And then he wants to use it. And honestly I can understand that. Cause why would you pour so much time and effort into something that might get thrown out next year? I did a lot of different lessons, and I can't, they're done. They're over. Too bad. Like, I had a really good lesson series that I used to give for Pythagorean theorem. Well I'm not an eighth grade teacher anymore. So guess what I don't teach? I wasted my time. Wasted it.

General alignment of views on effective teaching.

Tonya stated that her and the other seventh grade teacher’s general goal was to help improve their school, which was on program improvement at the time of the

interview. “I’m a ‘Title One teacher’, that’s what they call me. I’m here to save the day, you know? So our goal is to quit being horrible.” Other goals included having students write more about their mathematical thinking, keeping her job as a teacher, and helping to prepare students for college. She recognized that these were broad goals that did not pertain to mathematics instruction. “I don’t know if I would say that we’ve sat down and said this is, as math teachers, this is our math vision for our school. It’s more like, ‘We’d rather not get crucified.’ Like, that’s our goal. To stop being the crap school.”

Tonya described effective teaching as focusing on allowing students to have a deep understanding of content. “We do try to bring our kids to deeper understanding as much as we can with our constraints”. She valued engaging students in activities, and writing and discussing their ideas. She described herself as “good with mathematics” but that she was “not a really good teacher.”

In summary, Tonya described being “in a vacuum” with the lack of collaboration at her site with her fellow seventh grade mathematics teacher. Part of the issue was due to the fact that each taught different subjects. They shared curricular resources but did not plan together. Tonya stated that they both had the goal of improving their school, but noted that they have not sat down to discuss their goals for mathematics together.

Linkage

Tonya described having few connections to people, resources, or groups outside of her seventh grade group (see Figure 5-3).

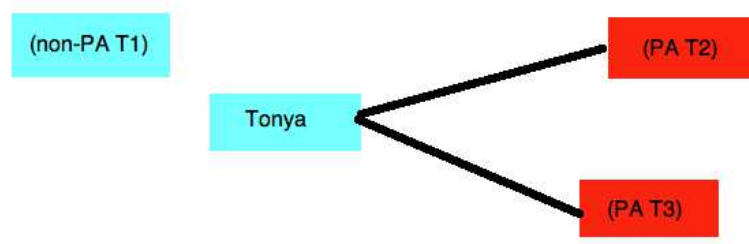


Figure 5-3. Linkage graph for Case 3, with seventh-grade teacher non-PA T1 and two eighth-grade teachers PA T2 and PA T3.

Tonya stated that other teachers had access to resources and did not specify which teachers these were, but stated that she did not in part because she had a difficult time remembering teachers' names and organizing papers. When asked if she had connections to people, groups, or resources outside of her grade level group, she said no. "Part of the problem is I have a really bad problem with names. So I can't even remember, even if I write it down. I'm not organized, so I lose papers. So no, not me."

Tonya noted that two of the three eighth-grade mathematics teachers, who participated in Project X, sometimes shared eighth-grade curricular resources that supported Tonya in planning for one of her classes that addressed seventh-grade and eighth-grade mathematics content in one year. "I just told them straight up. I said, I don't have time to plan all of seventh grade and eighth grade. So could you guys just kick me your stuff?" She also noted a former Project X teacher in the sixth grade yet did not explain that she worked with him. Tonya wished that she could join the eighth-grade teachers who were "really good about being together." She said that they created

materials together, discussed issues with one another, and were “really solidly, solidly cohesive, coherent.” She noted one instance when a TOSA coach visited her site to provide human resources, such as knowledge on a Common Core essential question. Yet she was skeptical about the knowledge she was supposed to learn. Noticeably, she did not describe the principal as a resource.

In summary, Tonya described having few connections to people, resources, or groups outside of her seventh grade group. Part of the reason for this was a difficulty with recalling names. Tonya sometimes received material resources like curriculum from two former Project X teachers in the eighth grade but did not describe planning lessons with anyone. She also noted one time when a TOSA math coach visited her site to share knowledge about Common Core essential questions yet questioned the nature of this interaction. She did not describe the principal as a connection that helped her to attract other resources.

Synergy

Unclear district goals.

Tonya stated that she did not know the district’s goals. She thought that the district wanted teachers to “do Common Core” and “be Common Core.” Tonya stated that the district wanted teachers and students to pass tests, which she agreed was a goal of her seventh grade group.

While Tonya explicitly stated not knowing the goals of the district, she suggested a different understanding when she stated that her current superintendent supported teachers. He was “more teacher-centered” than the previous superintendent, believing that teachers could write curriculum rather than fault teachers because they

were “not that smart” as the previous superintendent did. Consequently, Tonya reported that her superintendent led an effort for teachers to have material resources like paid days for some teachers to meet about creating curriculum because he wanted teachers to work together. “And so he’s actually the one encouraging some paid days for us to meet.”

Skepticism in district’s plan.

Tonya expressed skepticism with the way the district implemented the Common Core Standards, suggesting distrust between her group and the district. In particular, she expressed skepticism in the district’s view of ‘being common core’ and the human resources that a TOSA provided. One way she showed compliance to the goals of being Common Core to the district was by hanging a poster called “Are We Common Core?” with lists of activities (“Are we talking about each other's thinking? Are we revising our work? Are we using academic vocabulary? Do we believe we can get better if we practice?”). Tonya noted that she hung this on the board “just so when the guy comes through, he knows your Common Core. But he doesn't know. He doesn't know what common core looks like.” Thus, Tonya expressed

Tonya also described a time when a TOSA came to demonstrate a Common Core essential question.

Our TOSA came in and showed us what it meant. But he didn't really know. Cause when I asked him like, how do I write one, he's like, 'Well, what do you think?' And I'm like, 'Oh, we're going to Common Core this, are we?'

She replied to him that, “I don’t need to learn this and have deep knowledge, I just need to know what the heck do you want me to put on this piece of paper.” She also

wondered if putting a standard on the board constituted teaching in a way that aligned with Common Core.

You put that on the board [Are we talking about each other's thinking? Are we revising our work? Are we using academic vocabulary? Do we believe we can get better if we practice?] But it's just so when the guy comes through, he knows your Common Core. But he doesn't know. He doesn't know what Common Core looks like.

This evidence suggests skepticism in the district's method of implementing the Common Core Standards. In general, Tonya expressed frustration in attempting to align with the Common Core Standards, when she had no good examples of what it looked like.

Tonya also expressed skepticism about whether engaging students in the Common Core Standards was useful for students or a punishment for teachers. She said that that there was "all this Common Core garbage talk." "I feel like the Common Core's not really serious about us trying to develop deep knowledge in students. I think it's just a way to punish us even further and then disband public education." She continued to wonder why billionaires funded the Common Core without any input from teachers.

Tonya remarked how she thought it was strange that the district supported lesson study training in the beginning of the school year with many former Project X teachers and some new teachers, but left it to the teachers to engage in lesson study at their site. She explained returning to her site where nobody wanted to do lesson study after engaging in a district-led lesson study seemed like an unsuccessful use of time.

The district had us go do the ‘train the trainer for doing lesson studies.’ I went to the train the trainers course because they’re like, ‘Oh, you went to Project X. Go to that!’. And so we like learned how to facilitate. We did one lesson study in that time. At that, to talk about how to facilitate the conversations. And then like I came back here and nobody wants to do it. So it’s like, ‘Okay, that was a waste of a day.’

Tonya continued to discuss why nobody wanted to engage in lesson study at her site.

She cited a lack of time might have made it challenging even with three hours of paid time and one day to collaborate with others.

But you know what, part of it is [that] nobody wants to do it, because when are we going to plan? I mean, they, the district, said we can have 3 hours of planning time after school. It’s ours. That’s it. They’ll pay for that. And we can do one day where we take our grade level and get to meet together one day. They’ll do that. But otherwise, it’s like, if you want to do something for yourself that goes beyond what you’re already busting your butt to do, it’s on your own dime. And believe me, everybody’s scrambling. Because our district doesn’t have any type of curriculum at all for the Common Core Standards. So we’re just sort of pretending this year. Like pretending we know. I know what I’m doing. But it’s hard to come up with lessons every day that are, meet that standard without anything.

Thus, a lack of material resources like time and a curriculum were part of the reason that teachers did not want to continue lesson study at their site after the district attempted to align material and human resources. Tonya summarized her view on the district’s attempt to support lesson study by expressing the challenge of trying to find teachers to engage in lesson study at her site, concluding that perhaps the district thought the training was “supposed to be magic or something.”

The district says they want us to do stuff. But I went to that training. I don’t know if it’s supposed to be magic or something.

Even in the staff meeting I was trying to talk about it. And then there's a lot of teachers that are really, the science teachers hate the Common Core. They think it's stupid and ridiculous. They didn't want to discuss it, you know?

In summary, Tonya described that the district had unclear goals about Common Core implementation. She believed the current superintendent in Long Pond supported teachers by believing teachers capable of writing curriculum and providing material resources like paid collaboration time and one day release time. Yet Tonya expressed skepticism in the district's plan, particularly surrounding the implementation of Common Core. She exemplified her skepticism when she recounted an interaction with a TOSA mathematics coach attempting to provide the human resource of knowledge on Common Core essential question. Tonya was not convinced of the coach's method nor content as to what were essential questions. She was not convinced that engaging students with Common Core Standards would help develop deep knowledge in students. Instead, she thought it could be a way to punish teachers and disband public education. Finally, Tonya did not understand the district's plan for teacher collaboration when they supported one day of lesson study in the beginning of the school year then left it up to teachers to engage in lesson study at their site. She noted that teachers did not want to engage in lesson study at her site. These themes suggest overall weak synergy between Tonya's group and the district.

Summary of Case 3

Overall, Tonya's group showed low levels of integration, linkage, and synergy. With respect to integration, Tonya described being "in a vacuum" with the lack of collaboration at her site with her fellow seventh grade mathematics teacher. Though

they sometimes shared curricular resources, they did not plan together. Tonya stated that they both shared the goal of improving their school, but noted that they did not sit down to discuss their goals for mathematics.

With respect to linkage, Tonya described having few connections to people, resources, or groups outside of her seventh grade group. Tonya sometimes received material resources like curriculum from two former Project X teachers in the eighth grade but did not describe planning lessons with anyone. She also noted one time when a TOSA math coach visited her site to share knowledge about Common Core essential questions yet questioned the nature of this interaction. She did not describe the principal as a connection that helped her to attract other resources.

With respect to synergy, Tonya described that the district had unclear goals about Common Core implementation. Tonya expressed skepticism in the district's plan, particularly surrounding the implementation of Common Core. She exemplified her skepticism when she recounted an interaction with a TOSA mathematics coach attempting to provide the human resource of knowledge on Common Core essential question. Tonya was not convinced of the coach's method nor content as to what were essential questions. She was also not convinced that engaging students with Common Core Standards would help develop deep knowledge in students. Instead, she thought it could be a way to punish teachers and disband public education. Finally, Tonya did not understand the district's plan for teacher collaboration when they supported one day of lesson study in the beginning of the school year then left it up to teachers to engage in lesson study at their site. She noted teachers did not want to engage in

lesson study at her site. These themes suggest overall weak synergy between Tonya's group and the district.

Case 4

Integration

Alignment of visions of professional inquiry.

Kerry and Don both described a view towards professional development about inquiring into their teaching practice. Kerry and her colleagues volunteered to engage in lesson study, and were “excited to take the more formal training that we got with the math grant and put it together with what we, you know, enjoyed from the science grant.” Kerry enjoyed collaborating with others to answer questions about instruction like, “why do we have to go through this, why do we have to write about it, why do we have to model it?” She stated that she grew her understanding of both mathematics content and how student thought about mathematics by engaging in grants like the science grant and former Project X grant, and doesn't ever want to “slide back into doing something quickly”. Don noted that they had to systematically investigate their practice in a new way that school year with respect to research and curriculum. “So now we had to not only be the teacher, we had to be the researcher, we had to be the curriculum writers.”

Don described a willingness to collaborate and grow with his colleagues, like suggesting ideas and listening to others' ideas, even though it had been a struggling relationship. He believed that it was useful to converse with each other. In fact, he stated, “there's collaboration all the time now. Before, you used to keep everything to yourself or you would just do your own thing. And now you can't do that anymore

because our students are all intermixed with each other.” But different opinions about how instruction should occur created challenging situations for teacher collaboration, he described.

Whenever you have more than one person in a conversation, you’re always going to have differences of opinions of how it should be done, how it should be taught, how it should be received by the kids. And I think it helps to converse. And that’s a very hard thing to go through.

Don described how he was not used to relying on other people to get a job done, and previously preferred to do it all himself so that he knew something could be done correctly. He described the quality of always wanting to be right as prevalent.

We as people always want to be right. Sometimes we’re not [right] through this [collaboration time]. And we have to kind of back down and [ask], ‘Is it really worth the battle? Or are we looking at what’s good for the kids, not for our own egos?’ Because we always want to be the best teacher, the best this. It’s a very humbling experience, to listen. Because I find that’s, that was hard for me. Because I want to say what I want to say because I’m right. And there’s other person, people just like me, and it kills us because we’re not always right. So I think we all have the right, the same goal, and I think we are better people because of the meetings, because of the discussions.

Yet even with his value in working on his own and dislike of the amount of time collaborating with others often took, he believed that working with his colleagues with the goal of helping students to learn and grow was important. He equated collaborating with his group to a relationship where people grow together.

And, it’s is like a good marriage. There’s gonna be the bumps, there’s gonna be the yelling, there’s gonna be the screaming. But you know, in the end we apologize to each other, and you know, we give each other a hug. And that we have the kids at mind.

That's what we always have to go back to, is, who is this for? And sometimes we gotta push our self away and say, 'It's the resource kid, it's the GATE [Gifted and Talented Education] kid, it's this kid who has to be reached by us. And your way might be better than mine. And I have to accept that.'

Due to the alignment of values on professional inquiry, I call this group a PLC.

Effective instruction for each student.

Both Don and Kerry described effective instruction as targeting each student to help them understand a topic or idea. The common goal among the PLC was to ensure that all children learned in their classroom. Don stated that effective teaching meant “reaching all the kids if you can.” Kerry explained that her view of effective teaching focused on designing a lesson “for everybody” that presents material in a way that builds depth and understanding in a way that allows students to demonstrate it. “Kids can talk about it. And they can show you. They can show you. They can write about it. They can explain it. And they own it.” She noted that having a meaning to go with numbers, the ability to draw pictures, and describe a concept in words were all important skills for students to have. Important in her conception of effective teaching was an emphasis on students discovering the concepts without the teacher directly telling them. “It’s not me delivering it to them, it’s me delivering opportunities for them to engage in the material and truly incorporate it into their schema.” She stated that she never gives students formulas anymore. Rather, she asks them “Can you think of a rule? What rule could we write to figure out the volume of a box?” She stated that they could figure out a formula on their own, which was important to her because “now it’s theirs. They’re never going to forget it. They already know it.” This was one of her “great joys” of being a teacher. “If I can give them the tools for them to be

successful, but they develop the understanding through their own work and activity, then it's theirs. It's not something that they'll ever forget." Kerry stated that each group member saw a large difference between students in the current year compared to what students last year could do, which she described as "night and day".

Remediation was an activity they engaged in to determine effective ways of learning for all students. This involved planning different activities to bring each student to where they needed to be to meet an objective and standard. "We have those who need a lot of remediation, those who just need a little bit, and those that have already passed, so they have an enrichment activity." Both Don and Kerry described using PLC time for remediation to move students forward who are struggling with particular concepts to where they needed to be. "We're actually planning for sessions where one teacher takes the students who've mastered the concepts and does an activity with them. And one or more teachers, depending on the need, reteach something that students had difficulty with."

Similar goals, different paths.

Don described having mostly similar instructional goals with his group but different ways of reaching them. He summarized this theme by saying,

There's just different ways of getting there. It's kind of like going home to your house. There are probably five or six ways to get there. And as long as you get home by the right time, then you're doing good.

This is one of the reasons why the goals were "getting there" with respect to being aligned. Kerry believed that all teachers in her PLC had a goal of helping students understand yet that each teacher was "unique and does it in a new way."

Principal Paula described that each year grade level groups had the opportunity to write and update their collaboratively created goals and visions.

At the start of the year, you know, we have our standard goals and objectives that we have district, school, then individual. And our school goals and our district goals commonly keep us, continuously keep us focused on the collaborative model as one of the main goals. And then from within that, their own collaborative teams develop their own goals or norms about how the teams going to work, and what their purpose is, and what their function is. So umm, their, their involved in that as well, so that their collaborative meetings can go as intended, with the indent and purposes.

She noted that involving teachers in developing their own goals for collaboration seemed to help teachers.

And that seems to help. That they buy in to that and have the opportunity each year to revise or revisit or rewrite any of those team goals or norms. That as long as they go within the district guidelines. And it is contractual within our district as well that they have collaboration time as well.

She noted that they created their own agendas for collaboration time.

In summary, with respect to integration, or common values, goals, expectations, or values, this fifth-grade PLC described a number of themes. First, there was a common theme among members of inquiring into one's own practice. The teachers together decided to use lesson study voluntarily to create, co-teach, and debrief an ELA lesson to learn more about standards. Second, Don described a productive struggle to reconcile differing perspectives among his PLC members. Third, both Don and Kerry emphasized a focus of instruction on supporting each individual student wherever they are on their spectrum of understanding about a

concept or topic. Lastly, both Don and Kerry recognized that teachers in their group have similar goals but also have and appreciate different ways of reaching those goals.

Linkage

Don and Kerry described mainly working with the fifth-grade teachers at their site, which included Don and Kerry who participated in the Project X grant, and Clare, who participated in a grant before the Project X grant called SIESMIC that also used lesson study as part of its design (See Figure 5-4).

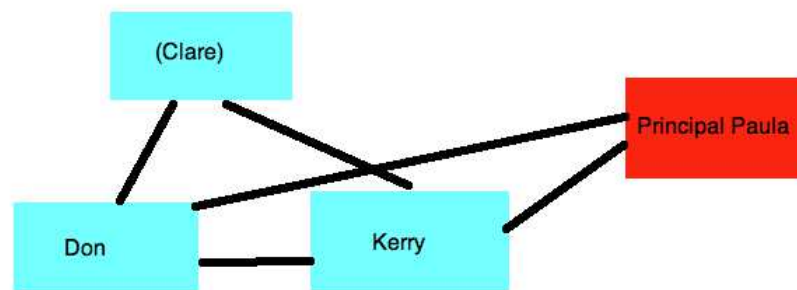


Figure 5-4. Linkage graph for Case 4, with fifth-grade non-PA Clare and principal
Linkage graph for Case 4, with fifth-grade non-PA Clare and principal.

Kerry's role as the representative for the site's leadership team served to attract human resources about Common Core trainings to the PLC. It was during one of these meetings that Kerry suggested all teachers at her site try lesson study. Don also stated that he served as mentors to other teachers at his site who were in need of guidance from teachers who had experience with Common Core. For example, Don described working with fourth-grade-level teachers about Common Core topics to discuss what students needed to know for success in the fifth-grade. "So we talk to the fourth-grade teachers, 'Here are our standards, here are our objectives. Can you make sure that you

prepare them for this?” The principal pointed out Project X teachers who were “going to be your teachers that you want to turn to for advice,” Don stated, due to their three years experience with Project X. Principal Paula confirmed this by stating that she “tap[ped] into that resource of those highly trained teachers who understand in depth collaboration when it comes to planning and instruction” when her site was looking at how to grow the capacity of all teachers especially with respect to the Common Core Standards.

I've obviously known for a while that I have five teachers who participated in it [Project X]. And they're still here on this campus. So, this year, when we did, when we were looking at how to continue to grow in capacity of all teachers, especially with new Common Core Standards, I thought I really need to kind of tap into that resource of those highly trained teachers who understand in-depth collaboration when it comes to planning and instruction.

Thus, Principal Paula identified some of her teachers' human resources and asked them to serve as mentors.

Both Don and Kerry described that they could reach out to others given the time and a need, like a question or to share something productive with others. “If we have a question or we want to share something that worked from that program and it's working with the Common Core math, for example, then we share the ideas.” In general, though, both described not working with former Project X teachers. Don stated that, “unfortunately, with trying to plan all the curriculum, doing everything, the last thing we have time for is to meet and discuss old times or the Project X unless there's a need for it, I think.” Kerry described feeling connected to outside resources and people. “I feel like I can reach out and ask the experts if I need to.” Yet she

described that this school year felt like “we’ve gone back to being isolated from the other school sites” due to a feeling of being “buried” with Common Core implementation. Don echoed this sentiment when he described few other connections to outside resources, people, and groups. The main reason for this was due to a lack of time since his group was busy inventing many of their own resources without any already made lessons.

These teachers did not describe connections to math coaches.

Lesson Study.

Don and Kerry both described voluntarily engaging in an English language arts and science lesson study with their PLC. “It wasn’t ordered by the district to do this. We actually volunteered to do it. We wanted to try it.” The district wanted the leadership team to return to their sites and unpack a unit-planning component designed by teachers in the district and then take the student assessments. As Don explained, the PLC used lesson study as one way to engage in “self evaluation of what are you looking for in a Common Core.” “And that one is the first one that we’ve done, that we’ve been provided with time to do that kind of planning and collaboration.” They used their regular PLC time to examine a unit planning resource created by curriculum teams that indicated standards that teachers would have to teach to students. Teachers then took the student exam to see the standards that teachers needed to address. They targeted language arts standards using science as the reading material. Each of the three teachers taught 15 minutes of the lesson, and observed students to “see what the kids are doing” and monitor where they were in their understanding. “When you get to step back and watch what kids are doing and listen to what kids are saying, it’s really

powerful.” This was a change from how a teacher taught the Project X lesson. Rather than have one teacher teach the lesson like during Project X, he stated that they each taught 15 minutes of the lesson like during the former SIESMIC science grant. This demonstrates how the PLC combined “the best of both programs to get something that’s, you know, going to be the utopian lesson we hope.”

Don stated that after three years of engaging in lesson study, his team felt comfortable enough teaching in front of their principal, the superintendent, and other supervisors from the district that “you could send in the pope in you want.” Principal Paula noted that this PLC did not need any training or guidance for engaging in this lesson study.

In summary, Don and Kerry described having leadership roles among teachers at their site, sometimes meeting with other leaders or grade levels to collaborate and discuss issues surrounding the Common Core Standards. Principal Paula confirmed this when she noted she tapped into the Project X teachers as a resource to help other teachers learn knowledge, particularly with the Common Core Standards. Both teachers described having connections to resources and people outside of their group as needed and time permitting, though acknowledged they were busy with implications from the Common Core implementation. They described the activity of lesson study, which involved investigating standards, planning activities, enacting the lesson with each teacher teaching 15 minutes, and debriefing on the lesson using student work as artifacts to guide the conversation.

Synergy

District attempting to align goals.

Don described varying levels of alignment of his group's goals to the district's goals. He described sometimes receiving positive and guiding feedback from his principal - that they were "ahead of the game in this sense" or "we need to change this and this." Don also noted that administrators from the district "love[d] to come around, to observe, to see what we're doing." His principal often attended their collaborative meetings. Yet Don stated that individual teachers had their own goals on how to best support students - "[each teacher] has their own mission statement, too, of what the district [is] supposed to do, what we're supposed to do, to prepare them [students] for the next level." For instance, he questioned how much research went into the selection and ordering of a Common Core mathematics textbook by the district that was given to each grade level in the district, or a book selected by his principal on lesson study. "You get these books and you look through them and you're like, this has nothing to do with what we're doing." Though he stated that the district tried to support teachers, he wondered whether having a pilot program test the books to see if they are worth investing in would have been beneficial. "It's just a matter of stressing, I guess, getting stressed out on their [the district's] part to try to give us something without looking at it." He concluded, "I think they're [the district] trying, but everything is new. So everybody is like a beginner at this."

Don described this experience of designing new lessons during the current school year as being "thrown to lions". He felt as if there was not enough preparation on how teachers should find and create their own resources when previous resources, like a curriculum, were not available. At the beginning of the year, he described that

he and his colleagues wondered, “What are we doing? And everyone, we’re trying to rely on what we did in the past but that didn’t always help us.”

Interestingly, Don believed the direction of the district might be “heading towards the student study lessons” although he wondered why they were not “on board several years ago” when principals and other district workers were invited to Project X lesson study and development days.

And now all of a sudden they’re going to something that they could have been on board several years ago, and had a good head start. And now they’re back where we are with the Common Core, which is, we don’t know what it’s going to look like until it’s being taught by somebody who knows what they’re doing supposedly.

Leading own inquiry into practice.

Don and Kerry described volunteering to engage in a lesson study with their grade level group. Kerry stated that the principal was very excited that they engaged in a lesson study, which Principal Kate supported through asking the district to pay for three half-day substitute teachers to enact lesson study. The lesson was observed by district administrators as part of their yearly site visit.

Kerry stated that the district was impressed that she and her PLC had “already made that leap” of using lesson study to understand the Common Core Standards. She stated that her PLC was even “ahead of them [the district]”. She attended leadership meetings and had the chance to see that some schools were “still trying to convince people that Common Core’s worth the effort.” This was not the case with her PLC. She noted that understanding new standards required “really high quality professional development that goes over a period of years” because that was the type of PD that

“makes a change” in her view. She also noted that giving teachers equipment without training teachers how to use it, or having teachers attend six after school sessions for several weeks was not sufficient. “It takes intensive professional development over a long period of time to build confidence.”

Autonomy.

Both Don and Kerry described a sense of autonomy of his PLC. Don described a situation where the district relinquished control to teachers so teachers could engage in activities that could help them meet the demands placed on them during the transition to Common Core Standards year. “Our district decided to do was to let the teachers figure it out without a lot of direction, compared to some schools [who] hired consultants.” He noted that rather than hire consultants, the district decided to find expertise within the district and “let the teachers figure it out without a lot of direction”. “We went within our district to get the experts in our district to get on different Common Core committee.” These committees of expert teachers developed tests and gave information about relevant standards, and had teachers “come up with all the lessons to fulfill those needs”. He noted that this situation combined a number of current directions, including his experience with Project X, “they kind of married together what we're doing.” This synergistic approach of combining lesson study with the district’s current direction with respect to the Common Core was perceived to work well together by Don.

Don described that their PLC helped explain their lesson to the principal, resulting in support from the principal. When the group designed a language arts lesson study research lesson that used topics from science, the principal at first saw it

only as a science lesson. After Kerry explained it to the principal, the principal “came around to understand” that it was indeed a lesson that met the ELA objective. Don stated that they “had to almost educate the principal” of why the lesson met ELA objectives using the context of a science topic of plants, and not only science objectives.

And now she’s not so hesitant to come in during the lesson to listen to it. At first she’s like, she didn’t want the supervisors to come in, or like her boss will come and then totally be embarrassed with what is being taught. Now she’s like, I think she’s excited to hear what we’re going to do.

Another way this PLC demonstrated autonomy in their teacher collaborations dealt with their agenda. Don described how the leadership of his collaborations with other teachers changed over the years from being organized by an agenda that they could not deviate from to running the meetings as they saw fit.

We could not do research during some of our meetings. We just had a, we already had an agenda. And for us to deviate from that agenda, we never knew whether the principal was going to come in to sit in it, in our meeting. And we had to make sure we’re covering what she wants us to cover. Now it’s we’re, we’re taking more change of it because we have to do all the work. We’re saying, ‘This is what we’re going to use our time for.’

He continued to say that it was always a battle between what teachers think is important, who are “in the trenches” with students, compared to the distant administration. These examples demonstrate that this PLC had autonomy over their collaborations, which was more than they were previously used to.

In summary, both Don and Kerry described the district aligning resources, with some attempts more successful than others. For instance, the district buying the

material resource of a lesson study book was not successful, but the principal aligning material resources to support a lesson study was successful. Both Kerry and Don described being supported to choose to a large extent what the nature of their teacher collaborations looked like. For instance, they created their own PLC agendas and volunteered to engage in a lesson study without their principal telling them. Both the principal and the district supervisors positively supported this PLC. Together, this evidence suggests strong synergy with the PLC and the district.

Summary of Case 4

With respect to integration, or common values, goals, expectations, or values, this fifth-grade PLC described a number of themes. First, there was a common theme among members of inquiring into one's own practice. Autonomy in inquiring into their practice surfaced in their engagement in lesson study to examine ELA Common Core Standards together as a PLC and the creation of their own agendas to guide their collaborative meeting times, which focused on researching and creating new lessons that aligned to the Common Core Standards. Second, Don described a productive struggle to reconcile differing perspectives among his PLC members. He found it important to work with others with the goal of helping students to learn and grow. Third, both Don and Kerry emphasized a focus of instruction on supporting each individual student wherever they were on their spectrum of understanding about a concept or topic. Lastly, both Don and Kerry recognized that teachers in their group have similar goals but also have and appreciate different ways of reaching those goals. This suggests high levels of integration.

With respect to linkage, Don and Kerry described having leadership roles among teachers at their site, sometimes meeting with other leaders or grade levels to collaborate and discuss issues surrounding the Common Core Standards. This was confirmed by Principal Paula when described tapping into the Project X teachers as a resource to help other teachers learn knowledge, particularly with the Common Core Standards. Both Don and Kerry described having connections to resources and people outside of their group as needed and time permitting, though acknowledged they were busy with implications from the Common Core implementation. This suggests moderate levels of linkage.

With respect to synergy, Both Don and Kerry described the district aligning resources, with some attempts more successful than others. For instance, the district buying the material resource of a lesson study book was not successful to Don, but the principal aligning material resources to support a lesson study was successful. Both Kerry and Don described being supported to choose to a large extent what the nature of their teacher collaborations looked like. For instance, they created their own PLC agendas and volunteered to engage in a lesson study without their principal telling them. This evidence suggests high levels of synergy between the PLC and the district.

Cross-site results

I deepened my analyses on social resources reported in Chapter 4 by using a modified version of Gamoran and colleagues' framework for sustainability, analyzing integration, linkage, and synergy for themes within each of those categories for each group, formal and informal arranged ones, across four cases. Further analyses on all four cases provided opportunities to see more similarities and contrasts.

In the fourth and fifth GLG groups in Case 1, teachers lacked integration, or alignment of values, goals, and expectations, with varying views of professional inquiry, effective teaching, and mathematics (in the case of the fourth GLG only). There was also a clear lack of alignment on how teachers wanted to spend their collaboration time. Though individual teachers reported links to other people, resources, and groups outside of their GLG, these connections were not always utilized during their GLG collaborations, due in part to low integration.

Analyses from Chapter 4 suggested social networks for teachers in Case 1, 2, and 4, with limited networks of people that Tonya in Case 3 for attracting resources. Further linkage analyses in this chapter showed that Case 1 was particularly well-connected among Project X participants, with a heavy use of their principal as a resource in large part due to his prior job as a middle school mathematics coach, Case 2 teachers were connected to principals and mathematics coaches, and Case 4 teachers were well-connected within their own grade level though not to mathematics coaches or their principal other than to help coordinate logistics resulting from their own creations during collaborations (e.g. request and completion of engaging in lesson study as a fifth grade team).

Levels of synergy were low with respect to each of the four groups at this site and the larger context of the district. Teachers expressed that they did not know the goals of the district beyond understanding the Common Core Standards. Some teachers expressed that they saw the district as assessment driven, and not in support of teachers' methods of professional inquiry like observing teachers or engaging in their own inquiries like with lesson study. Others were waiting for the district to

suggest a clear direction for teacher collaboration. Interviews with district participants like TOSA math coach Kimmy suggested that Long Pond school district provided material and human resources and left it up to individual sites to decide what teacher collaboration would look like. As an example, the district provided district-led lesson study training to teacher representatives from each grade-level across the site with the goal of having these teachers bring lesson study back to their individual sites. Fifth-grade teacher Mia noted that she was waiting for the follow-up of the cross-site training to see how it would occur at her individual site.

Other human resources provided by the district in addition to district trainings included the knowledge and skills of TOSA math coaches who visited sites across the district to help teachers come to understand the Common Core math standards. At the site level, the principal of case 1 provided additional human resources with respect to mathematics content and pedagogy due to his experience teaching middle school math. The district also provided material resource of time, offering to pay teachers for three hours of paid collaboration time outside of school hours and also give teachers release time for professional development. Though at the time the district had not provided many curricular materials for teachers, in part because the district had not provided a curriculum aligned to the Common Core Standards, teacher leaders were asked to write modules in June of 2014 to serve as curriculum for the following 2014-2015 school year.

Despite the alignment of material and human resources, teachers were not supported in engaging in the professional inquiry desired in both PLC groups – the PA PLC and the embedded fourth grade PLC with Bertha and Carmen. Factors related to

integration and linkage of a group were left unsupported, with teachers' views of professional inquiry, effective teaching, mathematics, and how they want to spend their collaborative time together not aligning among all group members. Some groups were more successful than others in attracting other resources through their linkages, or connections to people that attracted resources.

In Case 2, teachers again reported that alignment of teachers' views of professional inquiry, effective teaching, and how they wanted to spend their time mattered. While Anita reported moderate levels of integration with respect to her eighth-grade ELA group, Kamille and Nancy both reported low levels of integration with respect to views of effective teaching in Kamille's case, unclear views of the goals of group members, and lack of agreement on how to spend collaborative time. Each of the three teachers described connections to people, resources, and groups outside of their group. Kamille successfully utilized connections to math coaches to engage, though infrequently, with them and one other teacher for planning, teaching, and debriefing a lesson, and Nancy describing how she turned to TOSA math coach Dianna for help with strategies to question students' mathematical thinking. Though Anita's group saw her principal in full support of her group engaging in a collaborative effort like lesson study, Nancy's group thought the district was "biting off the whole chunk in one mouthful with Common Core implementation. Kamille's group expressed even more concern that the district's view of effective teaching aligned with their view of teaching. She stated that they did not understand her method of teaching, though she expressed some hope that the principal was coming to understand a "non-direct instruction" approach that focused on more than mastery of

skill. Principal Kate's interview suggested that she recently shifted her view of effective teaching to include "inductive" lessons that started with students exploring ideas without being told the "right" way to solve a problem right away. Kamille was not clear of the district's goals, suggesting another way in which her group had low levels of synergy with the district.

Tonya in Case 3 expressed low levels of integration, linkage, and synergy. Tonya described being in a "vacuum" with the lack of collaboration at her site with her fellow seventh-grade mathematics teacher. Though she and her fellow teacher shared the goal of improving their school, they had not sat down to discuss more explicit goals for mathematics. When it came to alignment of goals to the district, Tonya was skeptical of the district's implementation plan. She described frustration while working with a math coach to understand what an essential question was, and doubt that the new standards would even improve student learning. She also found the district-led lesson study training attempt frustrating when they left it up to these teachers to continue lesson study at her site, as no teacher expressed interest in engaging in lesson study. Together these suggested low levels of synergy between her group's general goals and the goals of the district.

Kerry and Don at Case 4 expressed high levels of integration, low levels of linkage, and high levels of synergy. The group's view of professional inquiry aligned, with each expressing a desire to learn more about the Common Core Standards through intense lesson planning, creating and following their own agendas for collaboration, and even using lesson study to examine ELA Common Core Standards. There were also integration themes of productive struggle to reconcile differing

perspectives among group members as well as a focus on supporting effective instruction for each student at their site. Their linkage levels were low due to the facts that they did not turn to the principals for human resources and instead asked her to coordinate material resources such as release time to engage in lesson study, they did not discuss working with math coaches, and finally, they only described serving as resources to other teachers at their site due to their knowledge of the Common Core by participating in the Project X grant. They found more resources within their own group, which resulted in high integration, and had the time to work with their own group. Due to their intense focus on designing new lessons and testing one out through the use of lesson study to do so and not due to a lack of desire in reaching out, they did not have the time to collaborate with others.

With respect to synergy, a strong theme of autonomy emerged between teachers in Case 4 and their site and district. Don and Kerry created their own agendas for their PLCs, volunteered to engage in a lesson study for their grade-level, and convinced others at their site with the support of the rest of the school's leadership team that the site should engage in a site-wide lesson study. They described serving as human resources to the principal, helping her to learn about how lesson study could be used to create and co-teach a lesson that targeted ELA standards while using the discipline of science to serve as content of the lesson. Low autonomy was exhibited in Case 1 when Bertha stated about the lack of clarity of district goals and ways to reach goals,

I think they're kind of just trying things, which is, you know, that's normal. They're just, okay, what if we do this? It doesn't work and then nothing happens for a long time. And we're left like, Okay now what do we do? You told us to do this and now what?

Mia, who taught at the same site as Bertha, described that agendas came from a number of sources, including principal's suggestions, grade level leaders, or by teachers, with the reasons for agendas including "to look organized," "because something is due," or "because people have asked, hey are we going to talk about this?" Mia noted that agendas were not created by the administration and consequently there was more freedom at this site to discuss what teachers wanted to talk about. "But in that freedom, sometimes, you know, people. It could go either way. Freedom could be a good thing or a bad thing."

Ben also wanted to do lesson study site-wide at his school but had not made that happen at the time of the interview.

I would like to get my grade level, and I would actually like to get the whole school involved in a lesson study. Going through the process is where you learn about your content that you're teaching. I can read it in a book, and I can you know, see it go on the internet and research it. But there's something about meeting with colleagues who all have a different opinion. And it's in that struggle that I think it broadens your thinking. Hearing teacher a, teacher b, teacher c, 'No, I think it's this way,' 'I think it's that way,' 'No, I think it's that way.'

The presence of autonomy with Don and Kerry's fifth grade group suggested high levels of synergy.

High levels of synergy in Case 4 contrasts with some teachers' views of the role that the district played in leading teacher collaborations, which was to wait to hear what the district recommended. With the district's method of injecting material and

human resources, in the form of 3 hours paid collaboration time and a district-led lesson study training that was to spread back to the lesson study groups' individual sites, it is reasonable that teachers would wait to see what the district would suggest given low levels of autonomy.

It should be noted that all three principals reported enthusiastic support with their teachers engaging in lesson study. All principals were situated within districts that attempted to align some material and human resources. Each principal noted, though, the importance of ideas for teacher collaboration originating by the teachers. As was the case with the site-wide engagement in lesson study, Principal Paula described that the idea for doing this originated with Kerry, a former Project X teacher with two teammates who both had experienced lesson study during grants.

When applying the framework, it became clear that teachers described engaging in aspects of lesson study even if they had not completed an "official" round of lesson study. Teachers were aware that they still engaged in some practices of lesson study, and often explicitly stating that lesson studies caused them to view different parts of their teaching practice differently. It made me wonder what aspects continued? It also became clear when applying the framework that teachers held different conceptions of the purpose of lesson study. It made me wonder if teachers' conceptions of lesson study played a role in supporting or hindering their ability to engage in lesson study with colleagues.

Thus, the next two chapters are dedicated to examining these two ideas – what aspects of lesson study sustained, and what are teachers' conceptions of lesson study – and linking them to results from the sustainability framework. These data, from

teachers with a minimum of three years lesson study experience, serve as valuable insights in supporting teachers in continuing lesson study. Together, these results from applying the sustainability framework, examining what practices sustained, participants' conceptions of lesson study, and participants' descriptions on factors that would support them in continuing lesson study answer the research questions of this study, which rests on better understanding the sustainability of mathematics lesson study after external funds go away.

Chapter 6: Results on What Sustained

There's times where you get burned out teaching because it's just the same thing year after year. But if I allow the kids to do the, they actually are teaching me. And that's the exciting part because I get involved and I see something totally new that I never looked at before. And adults do the same thing. And I think that's a valuable part that you miss if you don't collaborate with each other. And there's no way to replicate that unless you actually do it. You can't read it in a book. You can't see it in your teacher's edition. You have to meet with each other. And you make those discoveries.

- fifth grade teacher and mathematics coach, Ben

To answer the question (2) what sustained about lesson study after external funding support ends, I report on the practices reported to have continued past the end of the grant. This analysis expands linkage results from Chapter 5 by reporting on particular activities of teachers, which are represented by the edges of the linkage graphs, across four case studies. At the end of this chapter, I summarize results across four cases.

In Chapter 1, I foregrounded a range of answers to my question on sustained from lesson study. I now describe four different answers to this question.

1. Case 1 involved some teacher participating in a **district-led** effort to continue with lesson study and significant practices of lesson study in PLCs.
2. Case 2 involved some teachers continuing **particular practices** of lesson study but not seeing these as an 'official cycle'

3. Case 3 involved a teacher **not continuing** lesson study in any practice of lesson study after participating in one district-led lesson study.
4. Case 4 involved some teachers engaging in **site-wide, teacher-led** science and English language arts lesson study.

Understanding these non-exclusive cases in greater depth is the purpose of this chapter.

To do so, I report on results from interview and survey data to see what practices of lesson study, if any, were reported by participants to have continued past the formal conclusion of the former grant. Participants were asked on both survey and interview data if they completed a cycle of lesson study since the grant ended. Note that not all participants surveyed chose to be interviewed, and not all participants interviewed completed a survey. Consequently, I focus these reports mainly on interview data and supplement these findings with survey data when possible.

To be clear on what I mean by engaging in lesson study, I refer to the theoretical construct of lesson study (e.g. Fernandez & Yoshida, 2004; Lewis, Perry, Hurd, & O'Connell, 2006). Recall that an official cycle of lesson study is defined as engaging in the planning, teaching, observing, and debriefing of a collaboratively (created or modified from an existing) research lesson emphasizing anticipating and responding to student thinking, with approximately 2 to 4 other educators, most often teachers, math coaches, and/or administrators (See Figure XX). Completing a second enactment of the research lesson with a second debriefing is optional. This definition aligns with the view of lesson study participants learned during the Project X grant work.

To count as evidence of the presence of an aspect of lesson study (like goal setting, planning, teaching, observing, student thinking, and debriefing), I restricted my analysis to the current school year. I also looked for evidence of teachers engaging in these aspects with other colleagues; lesson study by definition involves collaboration. The district-led lesson study involved all aspects of lesson study – goal setting, planning, teaching, observing, student thinking, and debriefing – as confirmed by Kimmy who helped to facilitate it. Thus if teachers engaged in a full cycle of district-led lesson study, then their cells are shaded to signify participating in all those practices. If teachers described engaging in aspects of lesson study separate from the district-led effort, then their cells are shaded the appropriate aspect of lesson study. In other words, if a teacher only reported engaging in a district-led lesson study, and did not report engaging in other aspects of lesson study, then only the district-led lesson study box is shaded even though participation in the district-led effort necessarily implies engaging in all components of lesson study. If teachers participated in a full cycle of a teacher-led lesson study, then their cell is shaded to signify participating in all practices of lesson study, similar to district-led lesson study. If teachers discuss engaging in practices of lesson study in addition to either a district-led or teacher-led lesson study effort, then those cells are shaded.

Note that shaded cells do not refer to the frequency with which the participant engaged in the activity. Rather, shaded cells indicate that there was enough data to conclude the presence of a reported activity in that teacher's collaborations with others.

Table 6-1 summarizes each of the interviewee's reported participation in lesson study.

Table 6-1. Lesson study aspects reported to continue with individuals across four cases.

District	LP					SV			LP	SV	
	Case 1					Case 2			Case 3	Case 4	
	B	C	J	B	M	A	K	N	T	D	K
Full Cycle											
District-led LS		■	■	■	■				■		
Teacher-led LS										■	■
Aspects											
Goal Setting		■			■		■			■	
Planning	■	■	■	■	■	■	■	■		■	■
Teaching							■				
Observing			■		■		■				
Student Thinking	■	■	■		■	■	■			■	■
Debriefing	■	■	■		■	■	■				

Case 1

Case 1 represents teachers who engaged in a district-led lesson study effort in Long Pond school district. It also represents teachers reporting aspects of lesson study that have continued, along with Case 2, which will be described following Case 1. See Table 6-1.

District-led Lesson Study

Most teachers at this site described engaging in a full cycle of a district-led lesson study, though not together on the same lesson study team. Carmen, Jimmy,

Ben, and Mia each served as a facilitator of a mathematics lesson study for elementary grade teachers. This lesson study effort was facilitated by the district who supported lesson study after the end of the grant. During this post-grant effort, teachers were selected to be participants or math coaches for one cycle of lesson study. These new lesson study teams comprised teachers from multiple school sites teaching at the same grade level. Lesson study teams were supported with three hours to plan a lesson. They then enacted the lesson and debriefed shortly afterwards.

To describe this experience in greater depth, I turned to Kimmy, co-investigator of Project X currently working for the administration as a TOSA. Kimmy suggested and encouraged the Long Pond assistant superintendent to support lesson study with material and human resources. This included one half day to plan the research lesson, and one whole day to teach and debrief the research lesson. To support one teacher selected from each grade level, the district trained these teachers in lesson study at the district office. As Tonya noted in Chapter 4, it was a “train the trainers” workshop on leading lesson study. Kimmy noted that the intent for this workshop was to give teachers the knowledge and skills needed to lead a lesson study at their site after engaging in this district-led effort.

Mia described the nature of how teachers participated in this district-led lesson study cycle as problematic. This was due in part to Mia’s observation that the participating teachers had not understood for what they had signed up. Principals and administrators had not clearly described what would happen in these PD sessions, with participating teachers expected a workshop on the CCSS.

Basically it was teachers brought into a room, saying that they [participating teachers] were doing a Common Core development, and it was lesson study. And they didn't know why they were there.

She described some principals chose particular participating teachers to be involved because of the principal's perceived need for the improvement of certain teachers at their site. She said:

And a lot of the teachers were put there because principals wanted them to go through it, or thought they needed improvement. And so of course those are the resisters, 'I don't want you in my classroom.'

Consequently, Mia as well as Kimmy, a district coordinator and former middle school algebra teacher, answered many "Why am I here?" type questions. Mia also described this as having to "put out a lot of fires."

Mia hypothesized that the reason behind the bumpy implementation and enactment of lesson study was that the lesson study cycle "wasn't administered in a way that it was through the project." In Project X, teachers had a meeting to investigate and go at set, and a 6-hour day to plan the lesson, whereas this district-led effort only had 3 hours to investigate, set goals, and plan a research lesson. Additionally, district administration did not allow Kimmy - a teacher, math coach, grant co-PI, and district administrator with 6+ years of lesson study experience - to administer the lesson study cycles. "Kimmy got the funds for it and whatever. But it was done very haphazardly because. Kimmy had her hand in it, and then was told to take her hand out." Kimmy also reported a similar difference between the district-led

effort and Project X, explaining that the district did not let her facilitate this effort in a similar way that she did with Project X.

Aspects of Lesson Study

In Chapter 5 I described the Project X PLC as a highly integrated group with similar expectations for professional inquiry, expectations for student learning, and a preference to learn about their practice by engaging in activities (rather than read research or textbooks). This facilitated conversations about teaching and learning mathematics.

Teachers in Case 1 described engaging in an informal lesson study or components of an official cycle of lesson study as a PLC. Bertha said, “not in the way we did it [during Project X],” and Carmen noted that, “It’s not like how it is when there’s a grant.” With fifth-grade teachers, both Jimmy and Mia reported to engage in components of lesson study with the PA PLC, in addition to their district-led lesson study cycle. Jimmy stated that, “But informally we’ve done little pieces here and there.” Mia noted that “completed is the key word” when it came to doing a lesson study, and noted that she completed “components of lesson study rather than completing a full one.” Though they noted that they had not engaged in a full cycle of lesson study, they described engaging in the following activities.

Investigating.

Carmen reported investigating and goal setting with teachers outside of her grade level group, like first and second grade teachers. “What have you done? What are you doing? What’s your goal? What are you trying to get from them? And then from there it’s like, okay what can we do to engage the kids, first of all.” Mia

described engaging in informal investigations of activities with Ben and Carmen, including deciding questions to ask students.

And for us, like side notes, talking with Ben, talking with Carmen, saying, you know, ‘Okay this poetry version of the Common Core is really getting me. What are you using for a source?’ Or, ‘How are you using this, type of, like Essential Question driven thing? Am I too small if I’m giving each segment a question, or do I need to be more broad?’ You know, those kinds of things. I could talk to both of the because our relationship just lends itself to that. And that’s never really in a formal setting because I know they’ll take the time to talk to me, and they value doing things like that.

Here Mia described investigating the new Common Core Standards with her colleagues to learn more about how to target essential questions.

Planning.

Bertha stated that she and Carmen in their PLC “kind of” do lesson study and followed up to say,

We talk about, let’s plan the lesson. And then we teach it. And then, you know, there’s always questions like, Okay how did this work out? Oh my gosh, how did your kids do that? And then we talk about it afterwards. So that’s as far as it’s gone.

In Bertha’s example, she described the processes of planning and debriefing. Planning involved understanding key concepts like how one place value related to another place value, ways to introduce a topic, and understanding key words like “value”.

Now we’re going to be talking about place value. And what are the key concepts of the kids they need to learn. How do we introduce it? We talk a lot about what is value. And we talk a lot about compare it to place value. And how does one place value column relate to the next. So we plan like units like that.

Ben was careful to note that the nature was planning and not just sharing materials. He described that teachers collaborate together to find ways to teach concepts to students, and plan better ways to help students learn content.

Where the teachers are trying to figure out, ‘Okay, I’m teaching this concept, help me understand it better. How can I convey to the kids better?’ Not just, you know, give me a work sheet, that’s a good work sheet. Or, how do I do this. But really trying to figure out, I need to figure out a better way to teach this, really going into the why, instead of just the how.

One of the ways that Ben liked to plan lessons was by asking questions about mathematics with his colleagues just like he asked questions to his students while teaching.

So I love to ask questions, I could ask questions all day long and just build on that question, and ask another one right after that. And I love teaching that way. And even when I’m with adults, I still want to ask those questions because I think the answers in people, they just don’t know it. And the only way they know it’s there is if they discover it on themselves by asking questions, or by doing something themselves. Instead of me saying, ‘Well this is what so-and-so said, this is what doctor so-and-so said,’ people will sit there and go, ‘That’s a good idea.’ Or they’ll just tune you out. But if they can discover that concept on their own, they can own it and it’s more personalized.

Jimmy described his activities with Carmen and Mia as “a lot of it’s just discussion and talking about ideas on, on how we can present something, and questioning.” Mia also described investigating standards and goals with Carmen by developing mathematical activities and selecting tasks together.

Carmen at this site, she sees it very, not mathematically, but in a linear fashion. And I see it in a very visual way. And we can just kind of complement each other and go, ‘Well, I want them to see

this.’ And they go, ‘Oh. Well, that makes me think of this story problem or this context or this model.’ And so we can complement each other. And then I see the math behind what my models show, and what to extract with models.

In sum, Bertha, Carmen, Ben, Jimmy, and Mia each described planning activities around instruction together.

Student Thinking Focus.

Bertha and Carmen focused on student thinking in their activities together as a PLC. Bertha described discussing what students’ meaning of the word *value* with Carmen and how she could respond to these anticipated student responses (e.g. “what can I use to get them to say things like, you know it’s the worth of, of something?) In other data, Bertha also described asking Carmen particular questions about the mathematical reasoning of her students when Bertha did not know what to ask her students.

I usually am the one that has a million questions. ‘The kids said this,’ and, ‘Does this make sense?’ Or, ‘I got stuck here.’ Or, ‘I don’t know where to go next.’ Or, ‘I don’t know exactly how to ask the question.’

These are examples of a focus on student thinking, in particular, anticipating and responding to student thinking. Carmen’s discussions with members of the Project X PLC also had focus on student thinking, particularly students’ misconceptions in mathematics.

Jimmy exhibited a strong focus on student thinking during collaborations with Project X PLC. “So we’re constantly having those conversations about, you know, what the kids are seeing, and the little connections that they’re making. And stuff like

that.” Jimmy elaborated on this focus on student thinking by describing how Project X helped him to see the importance of questioning student thinking:

I think the most important thing that I got, that I got out of Project X and lesson study was the importance of questioning. And I just never, I never, it just never clicked for me. I never realized that. And to, to continue on and to delve deeper. I mean, there are times where I think back and I think, man I told that kid he was, that wasn't right! You know, why didn't I ask him to explain his thinking!?! Maybe it was right! and, and since then, I've had so many kids that have explained something to me, and I just went, wow. I would have never seen it that was. I would have thought it was wrong, you know, the way that you're presenting it. You know. And so, that again is getting in the classroom.

Mia also described a focus on student thinking as a practice when investigating goals for teaching, demonstrating both how she anticipated student thinking and how she would respond to them.

But definitely with people in our conversations going, ‘Here is what it says they need. What does that mean we do? What does that mean we ask them? How do I know when they know? When they're stuck, what do I do to that?’ You know, Do I say, ‘Here's another way,’ or, ‘Here honey, do this way.’ What do I question with? And that I think in me, just innately thinking, oh that's right. And knowing, it's not ‘Oh well, keep practicing.’ It's nothing like that. ‘Well what did you do when the whole did this? Or when that whole, when it said five of the $\frac{3}{4}$, or $\frac{3}{4}$ of the five groups. What does that mean?’

Though Ben did not specify the nature of student thinking during conversations with colleagues, instead talking generally about it, he gave one example of how he attended to student thinking in his own classroom.

And then I had a kid today, he said, well, he'd asked me, you said it's just like decimals. I said, okay let's talk about that. and then we talked about value, it's just another way to look at the number. so

then we took decimals. and then when you add the equivalent decimals, we still get a smaller number, or when we multiply it. So what's going on here? So again we have to examine those aspects that normally when I used to teach, I just said just multiply numerators and denominators, we'll call it a day and move on. And the kids and myself had no idea really what was going on.

Finally, Jimmy described somewhat of a focus on students in his fifth GLG. At least, he described a focus on student work and assessing student learning. “We look at student work, assessments, how kids are learning.” Ben and Todd both showed a focus on students’ thinking in the design of their new educational concept. For this concept, students would display their work to solving problems on whiteboards hung on all four walls of the classroom.

Observing.

The information here is incomplete in some regard. Several teachers and administrators report observing teaching with people to whom they were linked. Carmen recognized that she engaged in components of lesson study with her principal, at least with respect to him frequently observing her lessons for non-evaluative purposes. “But sometimes he'll [the principal] just, you know, talk to the kids, find out what. Kind of like lesson study, you know? Like, just observe, see what they're doing.” Although Carmen and Bertha do not report it, one of the TOSA mathematics coaches for Long Pond suggested that both Carmen and Bertha engaged in lesson study because they observed each other teaching.

Jimmy described observing his own classroom when his principal came to teach a lesson, “And then he's constantly in the classroom. He came in the other day and taught a lesson in my classroom,” and also observing fellow GLG member Todd’s

classroom. “I went into his classroom today and I'm watching. It's like, wow, okay. He's doing some good stuff.”

Interestingly, all of these references do not refer to a lesson that was necessarily co-planned but the reporter referenced them as an aspect of lesson study.

Debriefing.

All the references to debriefing were in the context of the Project X PLC or Carmen and Bertha's PLC. The debriefing is described as reporting what was noticed or a particular need, like help on interpreting or responding to student thinking. Jimmy described debriefing with his Carmen by having “conversations about what we're seeing” in the classroom. Mia debriefed with her PA PLC on instruction, focusing again on responding to student thinking. “But through talking with people and having them say, ‘Oh I like the way you did that!’ Or, ‘I think what that child really responded to was this,’ or whatnot.”

Summary of Case 1.

Four of the five teachers in Case 1 reported participating in a full cycle of the district-led lesson study effort. In fact, they each described being selected as a facilitator of these lesson study groups. Teachers here also reported informally participating in aspects of lesson study with one another according to their description and researcher interpretation. All teachers gave evidence of planning lessons with their PLC, and most described a focus on student thinking and engaged in debriefing of instruction.

In closing, teachers in this case did not report engaging in a lesson study with their GLG. This coincides with the reported low to moderate levels of integration, low

levels of linkage, and low levels of synergy for each GLG. Alternatively, most teachers reported engaging in aspects of lesson study with either the fourth-grade PLC or the Project X PLC, with Jimmy an exception since he described a focus on student thinking in his GLG collaborations. Recall that both the fourth-grade PLC and Project X PLC reported high levels of integration, linkage, and low to moderate levels of synergy. The teachers who were involved in a district-led lesson study (all but Bertha) reported varying levels of perceived alignment of goals to the district. Whereas Ben believed that the district's goals were in alignment with his goals, the others who engaged in the district-led lesson study like Carmen, Jimmy, and Mia did not report perceived alignment of goals to the district.

Case 2

Teachers in Case 2 also represent reported on aspects of lesson study have continued for teachers in Sun Valley school district. See Table 6-1 for a summary of the extent to which lesson study practices continued with Case 2.¹¹

Aspects of Lesson Study Continuing

Two teachers described participating in aspects of lesson study but not complete cycles. Eighth grade RSP teacher Anita recognized that she did not engage in lesson study like the grant, “no, not the way it was done”. But she said that she did something “pretty similar.” These teachers report working with others at their grade-level on late start Mondays and with TOSAs. Kamille reported that she did not engaged in lesson study but engaged in informal lesson study with TOSA mathematics

¹¹ Note that Nancy was on medical leave from September through December. Thus, Nancy did not have the same amount of time to engage in lesson study or aspects of lesson study as other teachers.

coach Curt. Kamille described that the closest she came to a lesson study was her work with TOSA mathematics coach Curt. When asked if she completed a lesson study, she said,

Unfortunately no [...] the closest I got was the one with [mathematics coach] Curt. And I say unfortunately because I enjoyed, I enjoyed sitting down with teachers, let's go through all the possible misconceptions, let's tie it out, let's narrow this down, let's teach a lesson, let's talk about it, let's reteach it. I enjoy that. Haven't been able to do that.

I now describe the activities that they report engaging in.

Planning.

Anita described plan lessons with her GLG colleagues, like updating an assessment before giving it to their students.

We [eighth-grade English teachers] don't fill out the [lesson planning] forms and do all that stuff. But we certainly, it's certainly in the back of my mind when I'm planning a lesson. Like, what I'm going to say and questions I'm going to ask and anticipating what they're going to say. So it's in the back of my mind, but we don't write it like scripted out like we did during the grant.

As Anita described planning lessons with her group, "We get to kind of figure out how we're going to get to where we need to get. We look at the assessments, and kind of try to plan backwards."

Kamille, the other seventh grade teacher, and Curt co-planned a lesson together for two seventh-grade mathematics classes. Afterwards, it was taught, debriefed, revised, and taught in another teacher's classroom.

Nancy did not report engaging in many aspects of lesson study but did describe working with TOSA mathematics coach Dianna with respect to planning lessons with a focus on questioning strategies to ask students.

Like I told Dianna, I love that questioning piece. and it's really tough when you don't have people to bounce ideas off of. It's really tough to come up with those questions. like, whenever Dianna gave an example or Rebecca, the one that I work with right now, you know, I'm writing the questioning style down. because it doesn't come naturally to me. But it is, more and more, but it's still, like the whole, how do you know? Can you prove it another way? Is there another way we can do this? How can we check that that way's gonna get the same result? Can we do it a second way so we can compare it?

Nancy's more typical collaborative activities with her GLG involved discussions on when they would have common assessments, the pacing of topics, and groups of students to target for remediation.

We collaborate on Monday, and all we really discuss. Once and a while we'll talk about practices. But most of the time, all we're discussing is when are we gonna give the next formal assessment. And where should we be right now. And who feels like this is overwhelming? (laughs) I mean, we're really only, I mean from my perspective, all we're ever really doing is deciding when are we doing the next task, what group are we going to be intervening with. We never really break down and really talk about, how are you teaching this? How are you teaching this?

Teaching & Observing.

Kamille described observing the mathematics coach teach a lesson that they collaboratively planned together. This occurred a number of times during the school year. During the lesson study described, Curt taught the lesson both times.

Debriefing.

Kamille reported debriefing and discussing the collaboratively planned lesson with TOSA mathematics coach Curt. They discussed whether they had met their objective, which was to focus on students analyzing and justifying mathematics, and clarifying misconceptions about the topic.

Student Thinking.

Anita reported reflecting on student thinking while planning and looking at assessments. She and her GLG colleagues shared student work samples while collaborating about whether assessments needed to be modified. Kamille also focused on student thinking during her debrief with Curt, “the kids needed to go a little bit deeper into something to clarify some misconceptions.”

Kamille described a focus on student thinking during her debrief with Curt, realizing that “the kids needed to go a little bit deeper into something to clarify some misconceptions.” Note that this could be further supported with more evidence as to the nature of discussions on student thinking.

Summary of Case 2.

In Case 2, teachers’ engagement in aspects of continuing lesson study varied. Both Anita and Nancy did not report engaging in a full cycle of lesson study. Anita reported engaging in most aspects of lesson study, including planning, focusing on student thinking, and debriefing with her eighth-grade language arts group, but these seemed to be disconnected with one another. Nancy did not engage in any of the aspects of lesson study except some planning with her GLG. Unlike the other two teachers in Case 2, Kamille engaged in an formal lesson study with TOSA

mathematics coach Curt, who was a former mathematics coach for Project X, and her fellow seventh-grade teacher. She did not describe it as a lesson study, perhaps due to the main role the mathematics coaches played in guiding the informal lesson study.

Case 3

Tonya reported continuing lesson study through the district-led lesson study effort at the beginning of the school year and did not report engaging in aspects of lesson study through her collaborations with other teachers. See Table 6-1 for aspects reported to have continued for Tonya.

District-led Lesson Study

Tonya engaging in a district-led lesson study with three other seventh-grade teachers in her district. She noted that she was selected because she participated in Project X.

Tonya elaborated that she met with other Project X participants to co-design and co-plan a lesson about complementary and supplementary angles. She explained that they engaged the research lesson in two different classes, an RSP class and a class called GEMS, which stood for Gaining Excellence in Math and Science through technology. After each lesson, the teachers debriefed and modified the lesson based on observations made during the lesson.

When we met, it was with people who had actually been in Project X. Almost all the teachers that they selected for math had been in the project. So we were like, 'Okay, this is like, we need to choose a topic. What's our timeline? Let's look at it.' And I happened to be with some very, very bright. I'm good with mathematics but I'm not a really good teacher. So but I was with some very brilliant teachers who are also good at mathematics. So it was really cool

because we could like decide the topic, flesh out the, the what it would look like, and then with the idea for, okay what's this new Common Core? How are we going to get kids come to understanding? We were able to do like complementary and supplementary angles without telling them the definition. We just worked to, to make a, make one that like, lead them to it. And then we did do, in classroom, we saw that some of our numbers were funky. Or why, why were students thinking that. And then we brought it out and we can back again after we revised. It was neat because we did the RSP class first, and then we did the GEMS, or like that magnet school class second. And then to see what their, how their minds worked and their solutions came together and their definitions. It was a big deal.

I think the biggest thing we got out of it was the vocabulary. The kids that, our RSP or low English, or even just low math skill. They also just completely lack any math vocabulary. They don't use it even when prompted they don't use. "Can you please use the word sum in your answer?" "Well, when they're summing..." You know? Yeah, so, but it was pretty cool. We did, and we revised it the lesson was awesome. I actually use it for all my classes. And so I have one really good lesson next year. (laughs) Well, then I think all these teachers that were there walked away with, like, 'Hey that is actually a good way to do that one.' So, one day out of a hundred eighty five. I'm good.

In the above passage, Tonya explained that they engaged in each of the aspects of lesson study – co-planning a research lesson designed to let students discover concepts without initially being told definitions, enact the research lesson once, debrief and make changes to address issues like “funky numbers”, enact the lesson a second time, and debrief on what students learned, such as mathematical vocabulary.

Tonya did not describe engaging in aspects of lesson study other than this district-led effort. That is, she did not report co-planning with her fellow seventh-grade teacher, nor any other teachers at her site. She did not debrief on what occurred during instruction with other teachers. Additionally, though she described that she and her fellow seventh-grade teacher wanted to help get their school off program

improvement and want students to do well, there was not a focus on student thinking during their collaborations. Tonya stated that they did not collaborate around instruction together. Instead, her collaboration time was used for meetings, like meeting with parents to discuss students' individualized educational plans.

Summary of Case 3.

In summary, Tonya engaged in a seventh-grade mathematics district-led lesson study with three other teachers in the district. She did not report engaging in any of the other aspects of lesson study with other teachers at her site.

Case 4

Teacher-led Lesson Study

Fifth-grade teachers in Case 4 described engaging in a teacher-led cycle of lesson study in April of 2014. See Table 6-1 for aspects of lesson study reported to continue for Case 4 teachers. The principal and administrators from the district office were present during the lesson study, including the director of curriculum and instruction.

Don described this lesson study as a way to engage in “self evaluation of what are you looking for in a Common Core [lesson].” Kerry elaborated on engaging all teachers at their site in lesson study.

We [teacher leadership] had to come up with an action plan for what we would accomplish the next time. And it was kind of spontaneous. I suggested it, someone else at the table suggested that we would try some lesson study. [*hooks arm and smiles*] And the principal was very excited that we wanted to do it. And she went to the district and got them to pay for the subs so that we could do that.

Kerry elaborated that they used lesson study to learn about the unit planning organizers created by other teachers in their district, which listed standards that teaches need to address. They then took the unit exam and designed a lesson to address the targeted standards.

The instructions we had was to look at the unit planning paper that the curriculum teams have put together. So it covers the standards you're going to cover. And then they give you the unit exam, and then you take it as a teacher. And then you look at the skills and the standards that need to be addressed in that, in this unit. And then you pick a lesson that you want to do. And that's what we decided to do. And we, it wasn't ordered by the district to do this. We actually volunteered (chuckles) to do it. We wanted to try it. And it was based on all of us participated in the ETT, yeah, ETT, EETT grant, which was a technology grant with the science alliance. And so we all had the science training. And those are all collaborative lessons that you develop. And you do several of them. And then you teach them at your site to your students. And that was a really nice model. Because each teacher takes a part, and it takes a little bit of the performance stress away. And so we were excited to take the more formal training that we got with the math grant and put it together with what we, you know, enjoyed from the science grant. And that's what we did.

Don and Kerry both described the goal setting and planning for the research lesson while engaging in lesson study. As Kerry stated,

The district really wanted the leadership teams to go back to their site and their grade level, and really go through the UPL, which is the unit planning piece, and to take the test yourself as if you are the student. So you get a really good idea of what responses. And we're doing this with language arts this year. They don't have the unit planning piece for math yet. I guess that's coming. So they were giving us a half day to really go through it with our team thoroughly. And we were the last team to plan our dates. We had the later date. And by that time, we had gone to the March meeting and decided we should try lesson study. So we used regular PLC time to do the unit planning and to take the test. So that we could preserve that half day for planning the lesson. And it was provided

by the district and they brought in subs so that we could be released.

Don noted that, “to sit down and do it, do a lesson study, there isn't the time nor is there the money for the school to give us that time to get a sub and to pay for that.” Consequently, Don, Kerry, and the other fifth-grade teacher used their weekly meeting times, both PLC and Common Core time, to research and plan their language arts research lesson, spending approximately six to seven hours to plan their 40-minute lesson. They asked their principal for release time. The principal was able to ask the district for three-half day substitute teachers so that these teachers could combine one of their classes and have all three teachers co-teach the research lesson. Administrators from the district came to observe the lesson including the director of curriculum and instruction.

As part of their teacher-led lesson study, the fifth-grade PLC described a focus on anticipating student thinking. They predicted what students might think and used these predictions as part of their lesson.

Then when you're three people, the feedback and the interaction between the writing of the lesson and the student study type stuff is as part of the lesson, we took what the Project X said of what are the kids responses? What are you predicting they are going to say? And then we say, if they say this then we have to say this because then that clears that up. Because one of our, then we have to make sure we're building up their vocabulary before hand so they understand what is a dwarf planet compared to a major planet, what is an asteroid. So the kids clear all this stuff up before the lesson, which is good too.

Don also described a student focus again when he said that they had anticipated ten different responses that students might say during the lesson. He was curious to see if these responses would appear during the lesson.

Our lesson has ten things that we're anticipating the kids are going to say tomorrow. I'd be curious when I'm not teaching this, that they're check check those off. Did they say this, this and this? Or will the second lesson be better than the first lesson because we anticipated all of these. Or else we tweaked the lesson to get that.

As part of their teacher-led lesson study, Don and Kerry described engaging in a debrief after the research lesson. As an observer of this debriefing session, I noted that they brought in samples of student work that they had collected from the lesson. The enactment of the lesson study mimicked Project X lesson studies except for two differences: all teachers co-taught the research lesson each taking fifteen minutes to lead the class, and they combined two of the fifth grade classes to have a larger than usual sized classroom.

Aspects of Lesson Study Enacted at Other Times

A majority of their interviews focused on the up-coming/recently enacted lesson study. Thus, many of the activities described by Don and Kerry focused on activities related to the recent teacher-led lesson study. I marked aspects of lesson study with this group when there was enough evidence to assume that they engaged in these aspects of lesson study *in addition to* their specified one cycle of teacher-led lesson study. I chose to under-estimate these aspects and not mark both boxes without evidence. I now elaborate on the evidence I found in addition to activities involved during the teacher-led lesson study.

Investigating and goal setting.

Don described investigating standards with other teachers at his site besides his grade-level group members. He described talking to fourth-grade teachers about fifth-grade standards and objectives to help these teachers prepare their students for the next grade level.

Planning.

In general this school year, Both Don and Kerry described that the fifth-grade PLC were writing lessons designed to address Common Core Standards during their collaborative meetings. Meetings in the beginning of the year focused on trying to understand what it means to write new lessons aligned to the Common Core. Kerry stated that,

We are planning math lessons for Common Core. And it's pretty much, we sit down with the standards, we look at the examples that our standards provide us with. And then we determine what needs to be done in order to thoroughly cover those standards in the time provided. So that's what we're doing. We're really creating lessons from scratch this year.

Don described finding articles to get information to plan lessons as opposed to use one curriculum.

We had to find articles. We had to do all the legwork. In the past it was all in the book for us. So it made it so much simpler. So now we had to not only be the teacher, we had to be the researcher, we had to be the curriculum writers. So then the hats got very heavy.

Because there was enough evidence to determine that these teachers co-planned habitually and not just once during their teacher-led lesson study, I marked planning in

addition to the teacher-led lesson study to signify that they both described planning in general and also planning for over six hours for one lesson study in particular.

Student Thinking.

Kerry noted that when conversing with her group, especially the teacher that did not engage in Project X with Don and Kerry, they often discuss a focus on student thinking, like students ability to draw a picture of a concept, describe it in words, and share solutions with peers. This focus on allowing students to come up with multiple solutions and see solutions of their peers' described a focus on student thinking during their collaborations.

And there's so much difference between having meaning go with those numbers. And being able to draw a picture and being able to describe it in words. And those sharing those solutions with each other. it's just fabulous. And they love it, they're waiting for it. "Turn to your neighbor and tell what strategy you think you might use on this." And they tell each other. and then I find one that's really unique and good, and they share it. And a whole bunch of aha. I mean, they're listening! There's all these ahas! they go, oohh I'm going to do it Danny's way. Yeah, that makes more sense! I'm going to do it his way. I like that way. If I said it, they would ignore me! But because somebody else in the class has it, presents it under the document camera, I mean, it's really powerful. And that partner work, share it with a group, share it with a class, that model is an every day thing now. And it's incredibly powerful. And they know how to talk about it. They know the words to choose. And they're very convincing.

Kerry also described that when she and Dave were not co-planning lessons together, they designed remediation for students, which meant focusing on the skills that each student needed to learn. To plan remediation, teachers were, "We're actually planning for sessions where one teacher takes the students who've mastered the concepts and does an activity with them. And one or more teachers, depending on the need, reteach

something that students had difficulty with.” Don also discussed remediation in his interview, suggesting a focus on student thinking.

Summary of Case 4.

In summary, Don and Kerry reported engaging in a teacher-led lesson study at their site, which they both described that they volunteered to do it. They co-planned for over six hours during their collaborative meeting times to prepare their research lesson. Kerry stated that they practiced the lesson once without students. Kerry, as part of the leadership team at her site, described that all teachers at her site engaged in a cycle of lesson study. Don and Kerry described engaging in other aspects of lesson study outside of their teacher-led experience, with both describing co-planning with colleagues with a focus on student thinking. Additionally, Don often discussed fourth-grade teachers’ goals to help these teachers prepare students for the fifth grade.

Finally, to learn more about how teacher-led and site-wide lesson study occurred at this site, I include the following excerpt from Principal Paula’s interview. In it, she summarized how a site-wide lesson study came to occur at her site by first describing a training at the district involving all grade level leaders from her site. She also described how lesson study gave teachers a reason to observe other classrooms and focus on student learning rather than teacher instruction, which she thought could help increase the number of teachers in other teachers’ classrooms.

Principal Paula: We had one grade level leader from each grade level participated in a district PLC model. And we were going there with the same team for, I think we went five times in the second semester. Our assistant superintendents had different types of, it was really kind of a PLC leader training, that was going on there, which was fabulous. And it gave those leaders a little more

capacity to come back and lead their PLCs on the site. And there were different topics each time, different activities, different things that they thought about and worked on together. And then it was, and then each time we were asked to develop an action plan of what are we going to do with what we learned today to go forward before next time we get together. What are we going to do in between?

Well, it came out of one of those planning staff development when we were at the district office. And I had at least two teachers on my leadership team that were in the Project X grant. And the other one was part of the, no she wasn't there. Just two from Project X grant. So somehow it came out as this would be something maybe we should try. And then all the teacher leaders, who were not all part of the grant, said, 'I agree. I think this would be great.' So when the leadership team decided we should do it or try it, then I came to kind of put together how it would look, the format, create the questions, the debriefing type questions, give them the release time to be able to do it, talk to the staff meeting. I presented at a staff meeting. 'And this is what your colleagues had decided we should do.' And then I kind of just pulled it together to help guide and support them through it.

So it really was definitely springboard. I don't think it would have just come out of thin air, if it wasn't for the fact that I had at least a couple teachers there who were very familiar and supportive of the Project X grant process. And so for them, it was kind of an easy thing to see the fit. I could see the fit as well, but someone who doesn't know of that lesson study would not really know how it's supposed to fit. So we just kind of just took a leap of faith and jumped in. You know, kind of had mostly positive, mostly positive outcomes from it. Couple of the things I think definitely had more to do with the lack of staff development training to understand a little bit better about what to focus on, what not to focus on, as far as just trying to plan together. That was a little bit deeper than what they've done before. And the amount of time it took. Those were really the only two negatives I heard. A couple had kind of just teacher style questions about you know, letting you come teach my kids. I don't know if they should see if you do such and such. I don't know. but you know, it was just a little more of that, little guarded a couple of them. And then, the time impact that it took away from their other PLC work in order to prepare and do this was another negative that I would like to remedy in the future.

Interviewer: Neat. That is really interesting to hear about. I haven't heard that kind of happening as I've gone and interviewed teachers.

Principal Paula: Yeah. I'm actually surprised it happened because like I said, I'd been wanting to do something like that. Because teachers will often say, 'Well we wish we could get into each other's classrooms. We wish we could go see what it looks like in there, you know, they know each other.' But they've never seen each other teach. And it's hard to find that time. And then we've tried to voluntarily, you know, we can get a sub if you want to go watch someone teach. Just tell that person you want to come in.

And it just didn't really ever work. Because then it's like, well what do you want to see? Why are you coming in? I'm not sure if that's a good time, you know? Even though people aren't, I don't know they're really threatened. It's just kind of awkward and uncomfortable when your colleagues says, 'Can I come in and observe you or watch?' But this was a way of taking away that 'I'm just coming into watch you' as 'we're just going to come in and teach this together.' So they really are learning from watching each other with their kids or other peoples' kids and focus in on the kids and the lesson rather than on each other's style.

So I think it [lesson study] kind of met all those different things that I think are important, when they say they don't get to see each other. We'd also just been studying, the district gave us, I think the leadership team had this Michael Fullan's article about the drivers for reform. And we had just read the article and shared about it. And the four most important things to focus on to really change the system is the building capacity, the group interacting together, focus on instruction, and make it systemic. And I think it hit all four of those by us doing this school wide lesson study shared teaching kind of like a team teaching kind of a situation.

Yeah. I want to do it again, we'll see how the staff responds. (laughs) They all went along with it the first time, but we'll see. I mean, I definitely think its, it's definitely worth trying again. And that was the outcome the leadership debriefed after because they all had to lead each of their grade level teams together through this. So we got together. And the conclusion we had was that it's definitely worth trying again. You know, there were some bumpy parts to it. It's definitely not something that we think should just

throw out and think was a mistake. But we definitely think it's worth doing it again, and trying to see if we can move on from there, and if they can find more and more benefit from it.

Summary of What Sustained

There were four different ways reported that these four cases in two districts reported continuing lesson study.

1. Case 1 involved some teacher participating in a **district-led** effort to continue with lesson study and significant practices of lesson study in PLCs.
2. Case 2 involved some teachers continuing **particular practices of** lesson study but not seeing these as an ‘official cycle’
3. Case 3 involved a teacher **not continuing** lesson study in any practice of lesson study after participating in one district-led lesson study.
4. Case 4 involved some teachers engaging in **site-wide, teacher-led** science and English language arts lesson study.

Case 1 represented groups of Long Pond teachers who reported to have engaged in a district-led lesson study effort at the beginning of the school year. As reported in Chapter 4, this effort was supported by TOSA former co-investigator Kimmy, who helped to coordinate and train participating teachers at the district office, and the assistant superintendent, who approved it. Teachers were selected from each site for different reasons, with many of the former Project X teachers selected to help Kimmy train new teachers in lesson study. Four of the five teachers reported that they facilitated lesson study groups in this type of lesson study in Case 1. Also in Case 1,

teachers engaged in many practices associated with lesson study in teachers' reported PLC collaborations.

The fact that many teachers engaged in an informal lesson study was noted by four of the five teachers. All teachers at this site reportedly co-planned with one or more teachers at their site, often across grade levels like was the case with Jimmy and Carmen, Bertha and Ben, and Mia and Carmen. Bertha reported co-planning with Carmen about mathematics lessons, exemplifying the focus on anticipating student responses and also reported debriefing on what occurred when each taught the lesson individually. Others reported aspects of lesson study that continued, including a focus on student thinking during collaborations, as well as debriefing with others, oftentimes about student thinking. This occurred across grade-levels within the Project X PLC, as in when Jimmy often debriefed with Carmen on what they saw during instruction of their own lessons. Mia also debriefed with her PA PLC after teaching lessons, again citing a focus on student thinking. Carmen and Jimmy described observing lessons with other teachers, with the principal often collegially observing Carmen's lessons and Jimmy doing observations with fellow GLG member Todd. These continuing practices were supported by high levels of integration within PLCs, such as shared visions of effective teaching and expectations for students, shared values of professional inquiry, and shared ideas of how to spend collaboration. The principal's knowledge was seen as a human resource. Teachers described access to material resources for implementing Common Core Standards and time, usually dedicated to issues around Common Core. The principal was seen as a resource for some, but not

all. He was reportedly a facilitator of material resources, with the exception of providing time for cross-grade level collaboration.

Case 2 differed from Case 1 in that Sun Valley teachers did not report participating in a district-led lesson study. Instead, all teachers described participating in varying levels of aspects of lesson study. All teachers described co-planning with other teachers about how to create new lessons aligned to Common Core Standards. Whereas Anita described additional aspects of emphasizing student thinking through sharing sample work and debriefing after lessons while collaborating with other teachers, Nancy did not describe engaging in these aspects. Seventh-grade mathematics teacher Kamille described participating in an informal lesson study with TOSA mathematics coaches Curt and Moe, where they co-planned a lesson, enacted and observed the lesson, and then debriefed afterwards. Anita described engaging in most aspects of lesson study. Anita also noted that she observed many other teachers' classrooms. This occurred in part due to her position as a resource specialist program teacher that taught students while they were in another class. Levels of integration were not as strong in Case 2 but they used their links to outside resources, such as TOSA mathematics coaches, to enable some of these practices continuing.

Case 4 Sun Valley teachers, who also reported high levels of integration, linkage, and synergy like in Case 1, reported engaging in a teacher-led lesson language arts lesson study to learn about the Common Core language arts standards and lessons that target these new standards. Their high levels of integration and synergy, like autonomy over their collaboration time with a 'hands-off' but supportive principal, facilitated their volunteering to use lesson study as a vehicle to learn more about these

standards. They reported arranging several weeks of their material resource of collaborative time to investigate and plan a research lesson, over 6 hours worth, and were supported by the principal arranging resources with the district to give these teachers three half-day substitutes so that they each could co-teach the lesson. The principal and administrators from the district office were present during the lesson study, including the director of curriculum and instruction.

Case 3 Long Pond teacher, Tonya, did not report engaging in any of the other aspects of lesson study with other teachers at her site. She reported engaging in a seventh-grade mathematics district-led lesson study, like the elementary teachers in Long Pond school district from Case 1. Tonya described an explicit lack of engaging in instructional activities with her fellow seventh-grade teacher, which can be seen in the low levels of integration as reported in Chapter 5. Also, she described a lack of material resources in Chapter 4, like collaborative time for instructional activities, and low levels of linkage to resources outside her group. Tonya's low synergy with the district, demonstrated in part by her skepticism in the district's goals, also seemed to constrain her from continuing lesson study.

By analyzing data to include evidence of aspects of lesson study sustaining, more teachers reported continuing lesson study though in different ways. Teachers in Cases 1, 2, and 4 reported continuing practices of co-planning lessons, debriefing lessons, and focusing on anticipating and responding to student thinking. In Case 1 and 4, this was supported by the availability of material resources and also high levels of integration and linkage. In Case 2, they continued as they could mostly through linkage to TOSAs outside their site. Teachers in Cases 1 and 3 reported engaging in a

district-led lesson study effort, making use of both human and social resources available to them in Long Pond district, but the Case 3 teacher had a deficiency of resources at her site and no linkages. The teacher-led lesson study in Case 4 was supported by high levels of integration among this PLC, high levels of synergy and autonomy over guiding their own collaboration time, and a principal who supported these teachers with the appropriate resources.

Now that I have described practices that were reported to have sustained from lesson study in each of these groups, I report on teachers' conceptions of lesson study, which can be seen as an important.

Chapter 7: Results on Conceptions of Lesson Study

In Chapter 4, I detailed the range of resources that supported participants collaborations. In Chapter 5, I studied social resources in depth using the modified sustainability framework of integration, linkage, and synergy, identifying teacher groups and the levels of integration, linkage, and synergy of each. In Chapter 6, I reported practices or aspects of lesson study that continued in each case. In this chapter, I report results of teachers' conceptions of lesson study to answer research question (2) on mathematics teachers' conceptions of what it means to engage in lesson. As part of this analysis on teachers' conceptions of lesson study, I conclude this chapter by reporting what teachers believed would support and constrain them in engaging in lesson study again. Providing results on teachers' conceptions of lesson study highlights an important facet to integration since shared conceptions of lesson study suggest the presence of shared values, expectations, and norms.

Part I: Results on Participants' Conceptions of Lesson Study

The following analyses center on interview data in which teachers were asked questions such as to describe what occurred during a cycle of lesson study, how they would describe lesson study to someone who had not participated in a lesson study before, and what lesson study was useful for.

I report results using the following method: (a) the *structure* or protocol associated with engaging in components of lesson study, where I used a priori codes from the literature (investigating and setting goals for research lesson, planning, teaching, debriefing, observing, optionally modifying and re-teaching the research lesson again, and a focus on anticipating and responding to student thinking), and (b)

Case 1 Conceptions of Purpose of Lesson Study

Although participants reported similar conceptions on the structure of lesson study, participants varied in their conceptions of the purpose or usefulness of lesson study. See Table 7-2 for an overview.

Table 7-2. Conceptions on the usefulness of lesson study across all cases.

Case 1	Case 2	Case 3	Case 4
Developing pedagogy	Developing pedagogy	Creating good lessons	Developing pedagogy
Learning mathematics	Usefulness for CCSS		Improving lessons
Focusing on student thinking			Improving student learning
Usefulness for CCSS			Usefulness for CCSS

Developing pedagogy.

Carmen reported that lesson study was useful for developing a teacher's pedagogy. Lesson study helped teachers to question the content and the purpose of teaching that content through the mechanism of reflection.

[Lesson study is useful] for everything. I think it's really powerful for developing pedagogy. And getting teachers to really question what they're teaching and why they're teaching it. And getting teachers to be really self-reflective. But not about the teaching. It's really about the learning. So, cause you hear teachers say all the time, 'Well, I taught it. I don't know why they didn't get it. I taught it!' So really reflect on the learning piece of it. And, and talk about, 'Okay, if they're not getting it, why are they not getting it?'

Ben also described lesson study was useful for developing pedagogy. He described that lesson study provided a “structure, a matrix so to speak, on how to do things in the classroom with your colleagues.” Ben reported that lesson study was also useful for designing curriculum and engaging teachers in collaboration.

Mia described that lesson study was useful for helping her overall with providing instruction for students and how to make instructional decisions.

I think for me personally that it was useful in knowing what to do with what you're given [...] Filtering out and going, What's more bang for your buck? Being on that pacing guide or having them understand what that strand is all about?

Mia stated that lesson study served as a lens that helped her understand what it meant to teach mathematics.

So the usefulness is just in the way you implement it, the way you think about it, the way you practice it and apply it. And then the kids taking it in, they're definitely going to learn more from a well-designed lesson. Or even just well-designed math class. Everything. To the structure, to the practice opportunities, everything. The use of homework, everything. It just got you, it gave you a lens of which to go, ‘That's what math class looks like.’

Additionally, she noted that it helped her to know what materials, like assessments and curricula, were useful to help her achieve instructional goals. She also appreciated the empirical aspect of lesson study and its close connection to practice.

You can give me a staff meeting and tell me how to be effective. You can give me a book that tells me how to be effective. I can read research and whatnot. But I won't know how until I've done it.

Finally, Mia exemplified how the process of lesson study helped her learn what it meant for students to justify mathematical explanations.

There's tag lines everywhere in teaching, as much as the acronyms. And for, and what does it mean, 'Did he justify his answer?' Well yes! He checked his answer. He used the inverse operation. Does that really mean to justify? I didn't know that when I started. I thought, 'Yeah, well yes it does.' So. But knowing what these terms mean, and what we want for kids. What does it mean to understand?

Learning mathematics.

Bertha and Mia both reported that lesson study was useful for learning mathematics content. Bertha stated that lesson study was useful for learning mathematics content and ways that it connected to other mathematical ideas. She stated that she learned mathematics content through the mechanism of conversations with others. "In talking to people who knew way more math than me, I learned so much. Even if I wasn't part of the team, just listening to people talk about math. Like, oh my gosh, I had no idea!" When further backing up her claim that lesson study was useful for learning about mathematics, Bertha recalled reflecting on what she and Carmen learned about multiplication during a past lesson study. She was looking at her "multiplication notes" when planning this year. She recalled that one of her notes said that kids say the value always increases when multiplying.

... Somebody was having a conversation, where they said, 'Yeah.' And I always thought that, too. But then they're talking about, 'Yeah, but what about when it's multiplied by 1 or 0? It does not increase.'

Mia stated that lesson study was useful for learning mathematics content, which allowed her students to understand mathematics better as a result. "So just delving into the skeleton of math and what it means. Usefulness there. And then the kids as a result are going to know because I know it more." Principal Ron also stated

that lesson study was useful for helping teachers to understand the mathematics deeply.

Principal Ron, who described engaging in several lesson studies in a different district while he was a middle school mathematics teacher, thought lesson study was useful for learning mathematics content, pedagogy, and getting teachers together “to talk about math and how you get kids to understand that math with someone who really understands the math as a facilitator.”

The value, of course, is having the time to really pull apart, what are the big mathematical concepts that we're trying to address. Which that conversation alone deepens content because you have to talk out the math. And then how are we going to get the kids to understand that math? That's the heart of it.

Focusing on student thinking.

Every teacher talked about a focus on student thinking as important component of lesson study. However, Jimmy described its role in changing teaching. Jimmy stated that lesson study was useful for providing the teacher an opportunity to observe student thinking. “To me the most important part is to, is to be an observer and watch the way kids learn from, you know, a role that's outside of the typical teacher role.” Observing student thinking was the mechanism for learning about the way students think. Observing student thinking also helped to change his perspective from the typical teacher role to one that focused on students’ mathematical understandings.

Usefulness for Understanding the Common Core Standards.

All five teachers thought that lesson study would be useful for understanding the Common Core Standards. In the fourth grade, Bertha reported that lesson study

was useful for understanding the Common Core Standards due to the planning and conversing of the students' mathematical ideas that occur in lesson study. Carmen also thought that lesson study would "absolutely" be helpful for understanding the Common Core. She described that lesson study's mechanism of reflection would help teachers to continue to ask questions and test ideas about new standards.

It's that reflective piece to the lesson study. That's the piece that you have to do if you're gonna teach Common Core. You can't teach something and walk away from it. You're constantly asking yourself, 'Did my kids persevere and make sense of a hard problem? Are the questions that I'm asking, do they even, are they even in line with what constitutes a Common Core type of question any more? Am I giving them too much? Or am I making it open-ended enough that it can be many different answers depending on interpretation?'

In the fifth grade, Jimmy reported that lesson study would be useful for understanding both the practices and standards of the Common Core. By engaging in lesson study around Common Core Standards, it would allow teachers to look deeply at student thinking, such as misconceptions students might hold.

The stuff that we're teaching is, is depth not breadth now. And so I think that lesson study, that's kind of at the core of it. You know, it's not about just throwing all the stuff at them, and having a bunch of teachers in the room and seeing how they react. It's about investigation and looking at their questioning, and where might they might be seeing things wrong. And misconceptions and all that kind of stuff.

Ben also reported that lesson study would help teachers understand the Common Core Standards since both Common Core and lesson study involved students in deep problem solving through participation rather than lecturing.

Because both of them, you're not lecturing them. You're getting the people involved. You're focus is on the people doing the work. Whether it's Common Core or lesson study, my focus is on what are the students doing. That's the focus. It's not on my lecture. It's not on the kid sitting there listening to me speak. It's on them actually doing the work. So like if they're sitting there doing the performance task, they're going to work at least two hours, maybe two days, on a particular problem. Maybe more than two days depending on the problem. To me, that's very lesson study oriented. The kids are doing the work, not the teacher.

Finally, Mia suggested that lesson study could serve as a vehicle for teachers to test ideas out, rather than find a solution by themselves or admit that they do not know the answer yet. This would be particularly useful with standards that are new to teachers.

We're teachers. We either research what we don't know, or we want to put a solution idea out there right away and not admit that we don't know. And so as teachers, we need to have programs like this that kind of inadvertently tell us what we don't know, and discover on our own, rather than someone say, 'Hey brush up on that a little bit.'

Through conversations with other people, they could learn what the Standards for Mathematical Practice meant. "Like modeling, you know, 'viable arguments', duhduhduhduh. It's like, 'What does that mean?'" And so just delve in. And to have other minds talk about it. To devote time to talk about it." Like Bertha, Mia noted that lesson study provided teachers the opportunity to engage in conversations like understanding a standard for mathematical practice.

Summary.

Just as they had high integration with shared expectations for students, common goals, and aligned notions of effective teaching, participants in Case 1 PLCs

had a shared understanding of the structure and purpose of lesson study. Participants and their principal described rich views on the purpose of lesson study, including to develop pedagogy, to learn mathematics, to focus on student thinking, and to understand the Common Core Standards.

Case 2 Conceptions of Purpose of Lesson Study

Developing pedagogy.

All three teachers in Case 2 saw lesson study as useful for developing pedagogy. Anita saw lesson study as useful for learning from developing and modifying lessons based on different populations of students.

I think it's useful for developing good lessons that you can put in your tool box. And then, that you learn from them, and then you change things up with each population. You see what works and what doesn't work.

Anita noted that her pedagogy changed as a result of engaging in lesson study, like the way she planned lessons. She reported that she now included how students might react to particular pedagogical moves. "I think a lot more about it, what's going to happen based on what I say." She also noted that she questioned students' mathematical thinking more after having gone through the grant. "And I think I question a lot more in my class in general." Learning from planning and modifying lessons, anticipating student thinking, and questioning student thinking were more ways that Anita reported to develop her pedagogy.

Kamille stated that lesson study was useful for both student learning and teacher growth. "Teacher growth. Student understanding. Teacher growth to help student understanding." Kamille described that engaging in lesson study helped her to

grow in the way she viewed her role in instruction and gain “a whole different mindset” about pedagogy, like how she questioned students with different purposes during instruction.

Just the way I look at lessons now isn't even close to how I used to, to a degree. I've always questioned kids. But now I'm questioning them with a different frame of mind. I'm just not saying, 'explain that to me.' I have a reason for saying, 'explain that to me.' And I'm always now thinking a step ahead of them. What could you say? Or why are you possibly confused? Or am I wording my question the right way? Does it make sense? So it's really changed my frame of mind in the classroom in what I thought I used to do wasn't really. I didn't think I used to be blind, but apparently I was.

Thus, Kamille grew in her ability to question students and anticipate what they might say, or in her own words, “changed my frame of mind in the classroom.”

Nancy also believed lesson study was useful for improving instruction and consequently student learning. Nancy thought that with lesson study, a teacher could make “greater strides with more effective instruction” compared to non-lesson study lessons. Through “different brains working together” during a lesson study and her coach who “allow[ed] us to kind of come to realizations” rather than tell teachers what to do,” Nancy deepened her pedagogy.

Usefulness for Understanding the Common Core Standards.

Both Anita and Kamille reported that lesson study would be useful for understanding the Common Core Standards. Anita stated that teachers could “definitely” use lesson study to understand the Common Core Standards because lesson study allowed teachers to understand how to involve students in thinking about mathematical connections to the real world. Anita stated that looking at Common Core

assessments felt like a similar activity that she had been doing for years. “That was what we were doing years ago. Like getting kids to think, you know, have like real life problems. Figure out how the math plays into that. But yeah, I think that definitely you could use a lesson study for all of it.”

Kamille believed lesson study would be useful for helping teachers to better understand the Common Core Standards for Mathematical Practice. By engaging in the process of lesson study that allows teachers to refine lessons based on their experiences and observations in the classroom, they can better understand what a practice standard means.

They’re all hand-in-hand. They’re all interrelated. You can’t say, ‘Understand the problem but don’t persevere in solving it.’ And with a lesson study, you’re teaching them, in my opinion, you’re teaching the kids to persevere, you’re teaching teachers to teach them to persevere. And you’re refining lessons as you go. Because you’re never always going to have that perfect lesson. Rarely it ever happens.

Principal Kate, who “loved the process” and thought lesson study was “awesome,” also saw lesson study in a similar way to the teachers at her site. She saw it as a process for improving teaching with a strong emphasis on student learning. She described lesson study as important for teacher reflection, monitoring student learning, and non-threatening teacher collaboration. With respect to teacher reflection, she thought lesson study helped teachers to learn how to take and give constructive feedback about a lesson, and “take advice from a colleague and just look at a lesson objectively and not so personally.” She further stated that, “It [lesson study] builds their ability to accept feedback in many cases. Not as being critical, but as in being,

being something that would improve student learning.” A focus on student learning resulted from the debrief while asking about what students did in the lesson, often evidenced by data collected during the research lesson. Doing this helped to take the collaboration “out of the personal zone.” She described that the “second chance” that came from teaching the lesson again after debriefing and reflecting on the collected data, like changing the way a question was asked, almost always resulted in a better lesson. Overall, lesson study helped to treat teachers as professionals with professional judgment. “It treats teachers as professionals with professional judgment. And they are real, really smart when they do it. They’re smart and capable and it builds their reflectiveness.” Thus, Principal Kate focused on lesson study as a process for improving teacher learning in a way that centered on student thinking.

Summary.

Anita, Kamille, and Nancy described very similar views to each other with regards to the structure of lesson study. Though their conceptions were not as rich as in Case 1, Anita, Kamille, and Nancy reported that lesson study was useful for developing pedagogy and understanding the Common Core Standards.

Case 3 Conceptions of Purpose of Lesson Study

Creating good lessons.

Tonya reported that lesson studies were mainly useful for creating and disseminating good lessons together with other colleagues. She described that collaborating with other “brilliant teachers” in her district would be good for “people like me” who could use the lessons.

There's people that are extraordinary teachers. When those teachers can meet with good teachers, good teachers like me can use their lesson and be great teachers for the kids' sake. So I think that's the beauty of lesson planning.

Tonya described using one of her research lessons for all of her classes. "And so I have one really good lesson next year," which she joked was only "one day out of a hundred eighty five". Bringing teachers together with different skill sets, like her knowledge of mathematics, could help to create good lessons with teachers' respective talents and share that knowledge. "That's the good part about lesson study. I think it helps everybody's, helps hone excellent lessons and then disseminating them a little better."

To examine whether Tonya had other conceptions of lesson study, I pressed for alternative conceptions. For instance, I wondered if she thought of lesson study would be useful for learning more about aspects of instruction, like understanding standards. I hypothesized that she would because Tonya stated that it was "hard to decide what they're [Common Core Standards] actually want us to teach," like what did the standard about showing a number and its opposite having a sum of zero mean?

Okay, what are you looking for on that? Are you looking for a model? Are you looking for a number line? Are you looking for all of them? How do you develop understanding? What kinds of numbers are going to be involved?

I asked her whether she thought lesson studies would be useful for understanding the Common Core Standards, like finding the meaning to what a number and its opposite summing to zero meant. Tonya noted that lesson studies would be helpful for helping teachers understand the Common Core Standards only *after* teachers knew more about

the standards. “Once we know what’s going on, lesson study might be helpful for meeting the requirements.” Tonya noted again that they would be useful once she better understood the standards. “I guess for Common Core, it’ll help *once we know it*. Then we could do lessons that are shaped about it.”

When pressed whether Tonya thought lesson study would be useful for understanding the practice standards rather than content standards, she stated that she did not know what the practice standards meant. Tonya expressed her dismay at having standards without “enough examples for what they’re looking for” where teachers “might get fired for not teaching it right.” “I don’t understand that,” Tonya noted about the lack of examples about standards she was required to teach. These data support the claim that Tonya saw lesson studies mainly as a way to create good lessons, and not additionally as a way to deepen her understanding of standards.

To further demonstrate Tonya’s conception of lesson study as a way to make good lessons, I present data where Tonya was sympathetic to her colleague’s view of waiting for other people to create lessons for him to use. She described her colleague, who did not want to engage in lesson study or collaborative planning practices, as waiting for other people to create lessons that he would use. Tonya was sympathetic to his view due to the changing standards and curriculum materials.

It’s like my other seventh grade teacher. He doesn’t want to [engage in lesson study]. He’s just waiting for other people to come up with good stuff. And then he wants to use it. And honestly I can understand that. Cause why would you pour so much time and effort into something that might get thrown out next year? I did a lot of different lessons, and I can’t. They’re done. They’re over. Too bad.

Tonya described an example of when she created a good lesson on the Pythagorean Theorem that she did not currently teach because she was no longer an eight-grade teacher. She saw it this as “wasted my time, wasted it.” All together, this evidence supports the claim that Tonya viewed lesson studies as useful for creating lessons, or reflecting understandings that a teacher already has, rather than growing and changing understandings.

In her interview, TOSA co-principal investigator Kimmy noted that many teachers who engaged in lesson study or were considering lesson study believed that lesson studies were time consuming. Kimmy’s data supports the views that Tonya held. Additionally, Kimmy noted that some teachers were reticent to changing their ways they taught when they hold the belief that they are a good teacher. “It's like, why would you spend that much time to design a lesson? Cause I've done this for all these years and I'm a good teacher.”

Summary.

Tonya reported that lesson study was most useful for creating and disseminating excellent lessons with skilled teachers. Tonya did not report that lesson study was useful for understanding something that she did not understand, which differed from conceptions held by teachers in Cases 1 and 2. Instead, Tonya focused first on trying to understand what the Common Core Standards asked teachers so that she could then learn how to successfully teach aligned to what they want and keep her job as a teacher. Missing from Tonya’s description was a sense of autonomy over her practices as a teacher. She did not believe that lesson study would be useful for helping her better understand the Common Core Standards – this had to happen before

she would engage in lesson study. This perception stands in contrast to teachers in Cases 1 and 2 who each saw lesson study as a way to understand implications of the new standards.

Case 4 Conceptions of Purpose of Lesson Study

Developing pedagogy.

Both Don and Kerry reported that lesson studies gave teachers a lens with which to look at pedagogy. Don believed that lesson study helped teachers grow and see things about instruction that they normally would not see. “I think the student studies give you that opportunity to grow as a teacher, to become better, and to look for things that you normally would not.” Rather than “just want[ing] to get through the lesson,” Don stated that with lesson study “you want to get through the lesson but make it better and better and better so by the time it comes the next year, then you feel more comfortable in yourself and you get the results that you’re looking for.” He stated that he was “saddened that it [lesson study] ended because you get a chance to grow with people.” Kerry believed that lesson study was useful for gaining perspective from another person’s view. “You’re seeing it not just through your eyes, you’re seeing it through other peoples’ eyes.”

Don saw lesson study as a collaborative way to improve as a teacher, or “to become better and more confident in what we’re doing” by “taking the best of all of them [colleagues’ ideas] into a lesson.” Lesson studies give teachers a chance to change perspectives to make use of other teachers’ observational skills for the purpose of seeing how students are understanding instruction. He noted that having teachers observe in the classroom involves observing the results of the teacher and not the

teacher themselves. “You have other people watching, not watching you teach and grading you on that, but they’re watching the results of what you’re doing. And they’re wanting to get some feedback and data to improve it.” Kerry reported lesson study as useful for helping teachers grow by engaging in well-researched and collaboratively planned lessons that were designed to help teachers understand whether students understand the concepts being taught. She described lesson study as “action research”, where teachers discovered whether a lesson, where teachers spent time investigating relevant standards, was successful shortly after it was taught and improved.

It stretches teachers, it helps them grow, it gives them a chance to, it’s like action research. You think you’re teaching a good lesson. But you might not find out ’til next week whether that lesson was what you thought it was, when you give the quiz or you give the test. With lesson study, you’re examining what you did right away the first time. You’re fixing it to see if you can make it better. And then you’re examining it again. So you’re getting results the same day. And you’re getting in-depth results.

Engaging in these experiences helps teachers grow because it gives them tools for improving their practice. She explained that by experiencing lesson studies together, she learned about how to use resources to plan lessons to elicit student thinking. Without it, she would not have a method for growing as a teacher: “I would not have known where to start [without lesson study].”

Improving lessons.

Don noted that lesson study gives teachers a chance to “revamp” lessons based on whether it is affecting students to learn the content. “You might be teaching the same lesson for twenty years. But if it’s taught and it’s not reaching more than a

couple of kids, then you need to revamp that lesson to reach more kids.” While planning for the lesson, Don described that he and his colleagues would predict what students would say and teachers’ responses to these predicted student responses. He noted that teachers monitored student thinking throughout the lesson, “sensing through their responses and their activities how they’re doing.” The observers of the research lesson collected feedback on how students reacted to the research lesson so that they may then improve the lesson.

Improving student learning.

Don and Kerry both noted that students learn through teacher’s investigations that give students well designed opportunities to learn, like lesson study. Don said that other teachers in the lesson study “see things that you [the instructor of the lesson] may not see” about student thinking.

With the student study, you have the other eye saying, ‘Well, you now, don’t pat yourself on the back too fast because you may not have reached this child. Or this child was confused about this. And when they’re [lesson study teachers] taking notes and they’re sharing the notes after the lesson, that’s why it’s [lesson study] is a good program. Because you think that you’re so darn good. And then they start saying, ‘Well this student asked this question.’ Oh, I didn’t anticipate that.

Don interestingly called lesson studies “student studies” throughout his interview.

This serves as an example of how Don saw lesson study as having a focus on student learning.

Kerry highlighted the importance of creating “quality experiences” for students that ask them to explore concepts and “delivering the opportunity for them to experience and wrestle with the concepts themselves,” without the teacher “delivering

information.” Kerry stated that students remember quality experiences to learn. “They retain that because it then becomes part of their thought process. And it’s so much more valuable.” Engaging in this experience changed how Kerry presented material to students with the main change being to include a concrete component to each lesson. “I keep it concrete as long as kids need it. I don’t rush to symbolic representation because there are kids that, if they have it in their hands, and they can build it, and they can walk around it and they can touch it, then they understand.” Kerry also incorporated specific activities that she learned from the grant into her classroom, like the use of a physical string as a number line to place index cards representing whole numbers, halves, tenths, and other numbers on the line. “When you get to step back and watch what kids are doing and listen to what kids are saying, it’s really powerful.”

Although Principal Paula was not a member of this PLC, she served to provide resources as one of their linkages to outside support. She offered her own insight as to the structure and purpose of lesson study. She described an understanding of lesson study similar to her teacher’s views. “As a tool for staff development and deeper thinking about what you're doing, I think it's fantastic.” She noted that it was “completely intense” , “extremely thorough,” and unrealistic to do with every lesson. She described how her whole site participated in a lesson study, with a focus on the enacting, observing, and debriefing components of lesson study.

When we took the idea as a skeleton and thought let's just try it school wide, we basically gave the staff no training. And some of them found their way through it with their own process. They kind of came up with their own schedule. We'll debrief first. Then we'll teach the lesson. We'll talk about the lesson, make any changes we

need to make, go back and teach the lesson again. And then look at the student work that we pulled together from the lessons we taught, see if we got what we wanted out of it, if there's something that we didn't get, the unexpected things that came from it. So that's kind of my understanding of it.

Principal Paula stated that she thought that lesson study was an excellent activity for teachers to engage in as part of their regular practice. Yet she was conscious of the amount of resources it took to engage in lesson study.

As a regular practice, I think it would be amazing if they had opportunities once a semester, two times a year, to be able to go through that process. Even if it's a simplified version of that. Kind of just scale it back. Cause you've been through it, so maybe you know what I mean, compared from that to what's realistic school wide on a campus. You can't release every teacher for how many hours a year was it? It was tons of days, eight days a year. It was a lot.

Usefulness for understanding the Common Core Standards.

Both Don and Kerry reported that lesson study would be useful for understanding the Common Core Standards. Don reported that engaging in lesson study would be useful for understanding aspects of the Common Core Standards and “give us a direction” on how to design instruction.

We didn't really have any directions this year. We didn't have a book that gave us all the answers. We had to kind of do like the student studies did. And [inaudible] so we had to get the information. Then also we put it all together. And then we have the right answer, or at least the right answer for right now. So, probably. It would be good to have that.

Thus, Don reported that doing lesson study would be useful for knowing what to do with Common Core lessons.

Kerry reported that lesson study would help teachers understand the Common Core Standards by giving teachers experiences, skills, and activities that teachers could use again. For example, Kerry stated that she used a number line activity that she learned of during Project X to engage her students in making sense of fractions, expanding portions of the number line, jumping distances to other numbers, and making predictions on where numbers would be placed. About this activity Kerry noted that, “They're getting the right answer, they're understanding what it means, and it's incredibly powerful.” Thus, lesson study served as a way to help Kerry learn how to help her own students learn, in particular the new Common Core Standards.

Summary.

In summary, both Don and Kerry reported the lesson study's usefulness for developing pedagogy, improving lessons through an iterative process, benefiting student learning, and understanding the Common Core Standards.

Summary of Lesson Study Conceptions Across Cases

Across all cases, participants generally described the structure of lesson study as including planning, teaching, observing, and debriefing a collaboratively designed research lesson focused on understand student thinking. Bertha did not emphasize the investigating and goal setting component, and Anita and Nancy did not emphasize the optional modifying and re-teaching component. A strong emphasis on student thinking occurred in each Case while planning the lesson, observing, and debriefing.

Teachers' conceptions as to the purpose or usefulness of lesson varied across the four cases. In Case 1, each Project X PLC teacher saw lesson study as useful for developing pedagogy, understanding the Common Core Standards, learning

mathematics, focusing on student thinking, and using lesson study as a lens. In Case 2, teachers reported the uses of lesson study as developing pedagogy and understanding the Common Core Standards. Tonya in Case 3 focused almost exclusively on lesson study as useful for creating good lessons. In contrast to others, she described needing to understand something like Common Core before being able to use lesson study. In Case 4, teachers reported lesson study as useful for developing pedagogy, understanding the Common Core Standards, improving lessons, and benefiting student learning.

Thus, all cases but Case 3 reported that lesson study was useful for developing pedagogy and understanding the Common Core Standards. Though both Cases 3 and 4 referred to lesson study as useful for lessons, Case 3 participant saw the main purpose as creating good lessons whereas Don in Case 4 saw it as useful for improving lessons through the iterative process of observing, modifying, and revising, in addition to his other reported uses of lesson study. Teachers in Case 1 emphasized the potential for learning mathematics by engaging in lesson study. Teachers in Cases 1 and 4 emphasized the role lesson study played with respect to revealing student thinking – in Case 1, Jimmy reported its uses for observing student thinking while in Case 4 Don noted that it revealed student thinking and Kerry reported that lesson study helped students learn mathematics due to well-designed and collaboratively created lessons that focused on anticipating student thinking.

Part II: Results on Factors that Support Teachers Doing Lesson Study Again

The following analyses center on interview data in which teachers were asked questions about engaging in lesson study in the future. Specifically, teachers were

asked what would be the biggest challenges to doing lesson study again. Their answer to what would be supportive of engaging in lesson study cannot be considered separately from their conceptions of lesson study. I report results using emergent codes from a grounded theory analysis on interview data. Survey data is used when possible to confirm teacher responses or to add more responses to make the results more rich. See Table 7-3.

Table 7-3. List of teachers' conceptions of supports for lesson study across four cases.

Support	Case 1	Case 2	Case 3	Case 4
time				
material resources				
learning how to give constructive feedback				
importance of facilitator				
teacher buy-in				
admin buy-in				
aligned values				
deprivitization of practice				
consideration of group structure				

Case 1

All five PLC teachers expressed an interest in doing lesson study again. Recall, they had similar conceptions not just of the protocol or nature of lesson study but also

its purposes and its focus on student thinking. The following factors were identified as an answer to what would support them in continuing lesson study.

Teacher buy-in.

Bertha and Mia referenced the importance of teacher ‘buy-in’ (a desire to engage in particular activities or endeavors) for supporting the continuing of lesson study. Bertha said:

I'll say some teachers on our [GLG] team don't really see the value behind the lesson study because they haven't been through it. They don't know what it is, and they just know that it's, oh it sounds like a lot of work. It sounds like a lot of time. It sounds like a lot of planning. I don't have time for that. I'm just going to do the lesson that I've always done.

Mia also stated that teacher buy-in would be important and that they would need to understand its purpose.

...to see it [lesson study] as something that is development. Or see it as something that is directly going to tie into your classroom. Not, ‘Why am I sitting [in] this when I'm not teaching it yet?’ Or, ‘Why am I sitting [in] this when it's really your grade level?’

Mia also said noted what was required, “So this, the culture of accepting what the goals are of the lesson study, and just coming together with groups. Like the gentleness in which you put that together, I guess. So. it'll take strong people.”

Ben explained that teachers needed to know why they were doing what they were doing earlier in the process of engaging in lesson study. He described that many teachers, including himself, did not understand the purpose of lesson study at first. He said that it took him until the second or third year to understand, “It's that collaboration. It's working with your colleagues to really understand what the concept

is and how to convey that information to the kids. But not just how to say it - how do I get the kids to discover this?" Thus, teachers understanding the nature of lesson study enabled teacher buy-in.

Time.

All five teachers in the PLC of Case 1 described that time would be necessary to continue to engage in lesson study. They described wanting more time to plan, more time to debrief, but also concern about the time out of the classroom. One teacher mentioned a desire to teach the lessons more than two times.

Bertha noted that approximately 50 minutes a week for PLC time was not enough time to plan the research lesson. She also understood that teachers did not want to plan afterschool after contracted hours. Fellow fourth-grade teacher Carmen also echoed this sentiment when she described that the biggest challenge in doing lesson study again would be a "huge problem" due to the time out of the classroom.

Somebody else has to be in your classroom. So what are your kids doing while you're out of your classroom? I know that that's the argument that a lot of teachers have, is "I can't be out of my classroom for x amount of days.

Carmen also thought that the planning portion of lesson study needed more time so that teachers could engage with the mathematics themselves and have time to anticipate student thinking. Jimmy and Mia also explained that there needed to be more time to plan the research lesson. Consequently, Jimmy noted that less time could be spent on planning a lesson depending on the goal if teachers used a lesson that is already mostly created in order to spend more time in the classroom observing student thinking: "You know, grab anything and do it. Because you know, every time I walk

into a classroom and start making observations, it doesn't matter what's going on. I can, I can learn something.” Jimmy also wanted more time to be able to teach the research lesson more than two times. Mia saw lesson study as a way to delve into areas she wanted to explore and wanted more time for planning:

It almost seemed like, you should start that, like a week or two weeks, kind of be brainstorming. Or teaching and be thinking like, what do I really want to delve into? What do I have the most questions about? Or where are the kids most needy in? So more time to develop your skill.

Ben believed that one challenge to finding more time was the lack of culture established around working collaboratively together to improve instruction for students. Ben believed:

So if it's to work, you have to find a way to pay for it. And that's a district problem, statewide problem, nationwide problem. How do you? We don't have that culture where we allow teachers to work together. In some countries they do. Our country does not. So that's the number one problem.

Carmen also pointed to the lack of culture around teacher collaboration on instruction.

Learning how to give constructive feedback.

Mia described that sometimes during debriefing sessions teachers did not know how to give feedback productively when something did not go well. Mia said, “So sometimes it was, what do I say? What is constructive and what's not? Or if I say this, will you take it as me just wanting to help or not? She noted that she was not a person who would “get very hurt,” but she knew others that would be hurt.

Sometimes even positive feedback was problematic for some teachers, as was the case with Bertha who felt uncomfortable when teachers gave feedback that

compared teachers to one another rather than the lesson. Bertha stated that even though the focus was on student thinking, she felt uncomfortable when one teacher's lesson went better than the other because it suggested one teacher did a poor job compared to the other. "Cause you can't help but compare. I know they're talking about the kids, but you know, the teacher's leading that."

Importance of facilitator.

Mia described that it was important to have a facilitator of lesson study that helped to direct and redirect the topic of conversation when it swayed from their main inquiry. She stated that she would want more help to narrow the topic and keep it focused on productive mathematics ideas.

Having more help, like I said before, to narrow down your lesson topic. You know, when you're a coach, and you have people talking about decimals, or you have people talking about, well you know I just want to tell them to line up the dots! And duhduhduhduhduh. How do you shield, you know, how do you shield their pride? You don't want to put too many people out, but you want to say, well okay, what is, what is that really?

Consider the structure of the teams.

Mia described that working with teachers in similar grade levels was needed for lesson study because "you needed to have the same, um, the same topics to be able to talk about it, and knowing about the same kids."

Summary.

Teachers in Case 1 described the following factors that would support them in continuing to engage in lesson study: defining the meaning of lesson study early to enable teacher buy-in, release time for engaging in lesson study (particularly, planning

and debriefing the research lesson), learning how to give constructive feedback, importance of facilitator, and forming teams of teachers teaching similar content.

Case 2

All three teachers in Case 2 expressed an interest in doing lesson study again. Anita thought that it would be “interesting” to do lesson study again. While she described engaging in the process as “frustrating” and “painful at times”, she now saw it as helping her to see instruction and learning from a different perspective. “Like I said, I do things totally different. And I just think about what I’m going to say to kids more. What I want them to do. What I want them to produce for me. I just approach it differently.” Kamille described wanting to engage in lesson study again. “I enjoy sitting down with teachers. ‘Let’s go through all the possible misconceptions. Let’s tie it out. Lets narrow this down. Let’s teach lesson. Let’s talk about it. Let’s reteach it.’ I enjoy that.” While Nancy also described that lesson studies could be frustrating, she thought that lesson studies were “incredibly helpful”. The following factors summarize what would support them in doing lesson study again.

Teacher buy-in.

Anita, Kamille, and Nancy described the importance of teacher buy-in. Anita noted that, “some people like didn’t want to do it. Or didn’t, thought the lessons were fine the way they were. They weren’t willing to change it or think differently.” She observed some colleagues will “keep doing it the same way” since “it’ll pass.”

Kamille noted that one of the main constraints to lesson study was that not every teacher was familiar with lesson study. This made collaboration in her grade level as well as vertical collaboration difficult, which would mean she would have to

find teachers from other sites to engage in lesson study. This, in turn, would require support from the administration in the form of substitute teachers to cover Kamille's class so she could visit other sites, which she did not believe "would be really welcomed from admin from me. Because I'm already, she [the principal] doesn't understand what I do." If others saw value in lesson study, especially the principal, Kamille thought she might not face the challenge of finding collaborators from other sites and the time required to do so.

Nancy noted that to do lesson study again, "I think the number one thing is it's got to be a group of teachers that have a common desire to want to be effective in the classroom, and that they're willing to put in the time and effort."

Time.

Anita, Kamille, and Nancy all described the importance of time for engaging in lesson study due to the length of planning, enacting, and debriefing with colleagues during a research lesson. Anita felt encouraged by her administration who supported her in observing other teachers' classroom by stating that they would find a substitute teacher to cover her class. "I've heard her, our principal say before if you guys want to watch someone, let us know. And they've encouraged people to go watch certain people and their strategy." Anita believed that her principal was "totally supportive" of Anita doing lesson study since the administrators "thought it [lesson study] was great. They loved it when we'd do that. They would come in and watch." Kamille stated that time and substitute teachers for collaboration would be needed to do lesson study again.

Aligned values.

Anita described an issue of teachers not valuing her perspective due to a non-specific focus in one particular subject area. “I always felt like the RSP or the special ed teachers weren’t, like, valued as much, their opinion valued as much as the general ed teachers. But I don’t know how that would change. Cause I think that’s just general how it is anywhere. Like we’re not considered the experts on content.” She continued on to say that other teachers often do not understand the challenges special needs students face. Additionally, Kamille described that administration education would be important for supporting teachers in doing lesson study. ‘Admin education, that’s the next grant.’ She elaborated by saying, “now that you’ve taught the teachers and we’re ready to go, go teach the admin so we can be ready to go.” Kamille described that support from administration would require a focus on student learning rather than teacher teaching when administrators observed the research lesson. Kamille wanted the administrators to be “open” to the teachers engaging in lesson study, as well be oriented towards students’ learning rather than teachers’ teaching.

Material resources.

Nancy and Kamille stated that material resources would be important. They mentioned the Van de Walle (2005) text, technology, and manipulatives were important.

Consider the structure of teams.

Kamille also noted that smaller lesson study groups were more effective than larger lesson study groups. Also, she said that it was difficult to watch another lesson study group’s research lesson when she was not involved in the planning. She said that

this was due to the fact that watching the lesson debrief was challenging. She preferred working with a smaller group to “just get down to the nitty gritty, analyze it, do it again.”

Importance of a Facilitator.

For some teachers, engaging in lesson study again would require a facilitator. “That’s a piece that really has to be there. Like if you’re going to do a lesson study, there has to be someone that manages adults that are not juveniles with respect.”

Principal Kate also noted that release time and a skilled facilitator would be important for supporting lesson study at her site. She stated that if she facilitated a lesson study, teachers might feel as if they are being evaluated. She said:

I feel like the discovery part of it and the autonomy part of it, without the evaluative potential, is a big part of the beauty of that process. Teachers feel free to, to mess up, to try again, to disagree, you know. And they don’t have to use what they might perceive as a buzz word.

Summary.

Teachers in Case 2 described the following factors that would support them in continuing to engage in lesson study: teacher buy-in, time (planning, enacting and observing, and debriefing research lesson), aligned values, material resources, administration ‘buy-in’, importance of a facilitator, and consideration of the structure of the group. Principal Kate also mentioned time and the importance of a facilitator.

Case 3

Tonya stated that many of her fellow teachers did not want to engage in lesson study. The following themes summarize changes that would help her to engage in lesson study again with a group of colleagues.

Teacher buy-in.

One of the most important factors for Tonya surrounded engaging in lesson study with teachers who desired to engage in lesson study or “initial buy-in”. Tonya stated that lesson study “only works if people want to do it.” Tonya wanted to work with teachers who helped to brainstorm ideas and were flexible about using others’ ideas besides just their own. “Instead of saying, ‘Well, this is what I’ve done in the past’, like [ask each other] ‘How do we get kids to answering this question for themselves? Let’s brainstorm, everybody come up with an idea.’” She even wanted teachers to have “to sign a paper that says, ‘I promise I will be flexible. I’m telling you, some people were very inflexible.’”

Time.

Tonya, like many other teachers, noted the importance of having time to engage in lesson study activities. She said, “The other teachers are like, I don’t have time for that. I don’t have time to sit down and spend six hours fleshing out a lesson with you and everybody else. And that’s one lesson when I could get a week of mostly a good lesson done in six hours.” Another point Tonya made stated that time cannot always be time during school, but rather be paid time after school since teachers “are away from our classes a lot anyways for all kinds of dumb stuff.” Time as an important factor to support lesson study was confirmed through Tonya’s survey data where she stated that teachers feel like there was not enough time for lesson studies

due to “all the planning and lesson changes we are making in order to implement the Common Core Standards.” Thus, paid time after school is another factor that would Tonya felt would support her in doing lesson study.

Consider the structure of the teams.

Tonya experienced a range of group sizes when engaging in lesson study. She found a group size of four to be better than any greater amount of people. If the group size was too large and had too many inflexible people, it was easy for a person “to steamroll the people that were trying to get through and be more cooperative. So, didn’t work so well.” Thus, small group size is a factor that would support lesson study for Tonya.

Deprivitization of practice.

Tonya described the importance of teachers opening up their instructional practices to other people, like during the teaching of the research lesson. She noted that not all teachers felt comfortable being the teacher of the research lesson because they did not want to open themselves up to judgment. Tonya elaborated on this theme by wondering why teachers felt criticized when they were in front of students all day.

There were some teachers like, ‘Well I refuse to deliver any lessons because you guys are just going to criticize me.’ And honestly sometimes it was just, they weren’t being criticized. They just felt that way. And it’s weird. Cause it’s like, you’re a teacher. You’re in front of kids all day. How come you can’t handle like, someone saying, ‘You know, probably this lesson should change like this’? But we have some resistance to that.

Material resources.

Tonya described wanting access to the lessons from the previous lesson studies from which to develop new lessons. She was not able to easily navigate the website created for the project for two reasons. One, sifting through and searching for lessons was not easy. Two, she liked having a physical copy that she could touch and that was not heavily technologically based since “Some of us aren’t techy.” Tonya concluded about lesson study that something that “teachers were hungry for” was “a way for us to get together, and not just do one lesson study but do a series of lessons that we put together as like, maybe even like within a unit, like a section or two. So that you could see how these lessons could build.” Without situating the lesson in a series of lessons it feels as if teachers dropped “this bomb into your class”. It often was challenging to plan when the research lesson would be enacted in a teacher’s classroom. “Trying to fudge your schedule around so that they have the prerequisite knowledge they need” for the research lesson was a challenge that if did not occur properly resulted in a “terrible” lesson. About enacting only one research lesson, teachers felt, “Great, I made one lesson. But who cares?” Teaching one lesson in isolation to other lessons was not helpful or functional to Tonya.

Summary.

The teacher in Case 3 described the following factors that would support her in continuing to engage in lesson study: time, teacher buy-in, consideration of structure of groups, de-privatization of practice, and material resources.

Case 4

Deprivitization of practice.

Kerry suggested having two or three teachers enact the lesson. She felt having multiple teachers teach the lesson would make the lesson feel more like a “joint project” and consequently more comfortable rather than “one person’s lesson” where one might feel judged. “So ...you don’t feel judged. But there isn’t the same level of pressure. And you have this camaraderie, which is really, really enjoyable.” She noted that one of the challenges with continuing lesson study lie in asking teachers who have never done lesson study to be the main teacher. Kerry’s suggestion on co-teaching the lesson, like each teacher teaching 15 minutes of the research lesson, could be one way to address this issue.

Time.

Both Don and Kerry highlighted the importance of having sufficient time for lesson study. Don said his grade-level spent the majority of their time trying to design lessons that aligned with the Common Core end of unit tests that they had received, which left little time to engage in other activities. He stated that in general, lesson study should be flexible enough to meet the needs of teachers.

What we’re doing is we’re taking bits and pieces of it, and trying to fulfill the needs that we have. But I think something like this should be open to improvements or changes to fit the needs of the teachers or the teachers that are using it.

Additionally, Kerry noted that involving multiple people who do not think similarly in a discussion required time to elaborate and talk about each other’s examples and time to justify their own perspective.

When there's three people involved, there's discussion. And none of us are exactly alike. And we don't have the same background, so we don't approach problems the same way. And what makes a good lesson good is all of those perspectives having to actually interact with each other and fuse together the best ideas and the best that each of us brings. And that takes time because it takes discussion and elaboration and talking about examples and justifying your perspective. And it's important that there's time to do that.

Without having the time with other people to have important discussions about instruction, Kerry felt the following: "If you're just in your head all the time, all you do is what you think is right."

Material resources.

Kerry also mentioned needing books for particular subject areas to assist in the understanding of the content so that teachers could design good activities. She said that unpacking what the standard means with examples and defining of important words helps teachers know what they are supposed to teach.

I think to make Common Core the most effective it can be, and teaching it the most effective it can be, there need to be resources or training so that teachers truly understand what it means by those words. What do they really want kids to be able to do? And without those models and that book, even with all my training, I would not have known that's what they were talking about... I'm afraid there are teachers that don't know they're supposed to be teaching it.

Principal Paula noted that if she were to do lesson study again, she would provide teachers at her site with lesson study training and collaboration time in addition to what they already currently used. The teachers also noted time but not training, in part because they already participated in lesson study for three years with the Project X grant. Principal Kate described that the training would help teachers to

understand what to focus on and what not to focus on while planning, and how teachers should engage in a debriefing session. She spoke from the experience of having supported lesson study site wide after two of the teachers on her leadership team suggested that they use it as a way to better understand unit planning organizers designed by teams of teachers at the district office.

Summary.

Teachers in Case 4 described the following factors that would support them in continuing to engage in lesson study: time, teachers' comfort with deprivitization of practice, and material resources for planning.

Summary of Factors Across Cases

Virtually every teacher mentioned the importance of time. Several mentioned that time was needed during the school day for planning or payment for teachers to work outside of the contracted day. Some talked of the need to help others understand the benefits and purpose of lesson study so that teachers would have buy-in. This was closely connected to the idea of having teachers who were willing to examine their practice and who had similar values. It was also connected to calls for a culture of collaboration.

Several mentioned the importance of a facilitator and one of the principals noted that it should not be seen as someone who was in an evaluative role. Teachers reported different alignment with the administration at his or her school and consequently a few suggested that administrator buy-in was critical. Some asked for more guidance in providing constructive criticism. The need for material resources ranged from more resources to help plan how to unveil the concept and anticipate

student thinking to access to technology and manipulatives when enacting lessons. Also, Tonya, who sees lesson study as a way to create great lessons, asked that she have a way to easily access previous lessons.

It is important to note that these factors are representative of all teacher participant responses in addition to those teachers within the four targeted cases.

Chapter 8: Conclusion

If you're going to be a teacher, you do have to remember what a student's doing. Because that's what we're enabling. That's what we're creating, this experience for the student. And if we don't remember what it is through the students' eyes, then we've lost touch.

- fifth-grade teacher, Mia

To support mathematics teachers in engaging in collaborative and sustainable experiences to improve their practice, teachers, principals, and districts need to know how to support it. In particular, lesson study has been described as showing great promise for being a sustainable form of professional development due to its few material resources. However, little research exists on how to support lesson study practitioners so that they can continue to engage in lesson study long after external funding ends. Previous lesson study research has described challenges of implementing lesson study, along with how it is beneficial for changing teacher knowledge and practice, and for developing communities. In this study, I focus on what would support and constrain teachers in continuing lesson study past the end of external funding.

I investigated practicing mathematics teachers' reports of who they worked with, what sorts of activities they engaged in, resources that supported their collaborations, teachers' goals for teacher collaboration, and how teachers conceived of lesson study. I also investigated principal and TOSA perspectives about teacher collaboration, the types of support that they and the district provided for teacher

collaboration, and how they conceived of lesson study. I asked the following research questions:

1. What practices of lesson study continued after the grant ended?
2. What conceptions of lesson study did participants have?
3. What factors supported and constrained teachers' ability to continue to engage in lesson study after the grant ended?

I approached this study using a sociocultural perspective on learning that posits learning to occur through participation in communities of practitioners as afforded and limited by the institutional context, like resources that support teacher collaboration. Continuing practices associated with lesson study do not immediately follow from resources allotted to teachers, but access to resources and structures can support teachers' continued and generative engagement in practices (Lewis & Perry, 2014). Material, human, and social resources can generate new resources for continuing practices.

I used a range of methods to answer my questions. The primary collected data was online survey data, interview data, and field note data. I interviewed 35 teachers, TOSAs, and administrators and through data reduction, chose to intensively code and write about a focus on 17 participants. The 17 participants included 12 teachers in upper elementary school and middle school, 3 principals of these teachers, and 2 TOSAs working at the district office, such as coaches and the former co-investigator of Project X who provided professional development. Participants spanned Long Pond and Sun Valley school districts. Importantly, the teachers and TOSAs had been a part of a recently ended a three-year grant that used lesson study as one of the main

vehicles for learning about algebraic thinking for teaching grades three through algebra.

I answered research question (1) by using a priori codes found in the literature on lesson study to characterize participants' reported practices of lesson study that continued (Chapter 6). I answered research question (2) using grounded theory to identify and categorize ways teachers conceptualize lesson study as well as what they believed would support lesson study if they were to do it again (Chapter 7). Their conception of lesson study was obtained from answers to explicit questions about the nature of lesson study as well as implicitly from other responses. I answered research question (3) by using a modified version of Gamoran and colleagues' (2003) sustainability framework involving integration, linkage, and synergy, and engaged in grounded theory analyses on teacher communities, both formally and informally arranged (Chapter 5). Grounded theory was used to derive and identify emergent themes from the data, with social network analysis used to better understand integration and linkage. The primary source of data analyzed included interview data, with survey data helping to triangulate some teachers' claims. Analyses on material, human, and social resources (Chapter 4) also provided a foundation for each of the three research questions.

Results from analyses of resources, the sustainability framework of integration, linkage, and synergy, practices that continued after the grant ended, and teachers' conceptions of lesson study all contributed to answering my three research questions. In what follows, I summarize these results and discuss the limitations of the study. I discuss practical and theoretical contributions that these results bring to the literature. I

also suggest recommendations for researchers and practitioners of lesson study.

Finally, I describe future research directions that were directly inspired by engaging in this study.

Summary of Results

In this section, I describe results from Chapters 4, 5, 6, and 7 and how each of these helped to answer my three research questions.

Availability of Resources

Evidence across each of the four cases (where Cases 1 and 4 involved elementary school sites and Cases 2 and 3 involved middle schools) suggested varying levels of access to what Gamoran (2003) referred to as three types of resources that help to support mathematics teachers engaged in teaching for understanding: *material* resources, or time and curricular materials, *human* resources, or access to knowledge from outside and inside schools that can be exchanged, and *social* resources, like attributes that result from roles or relationships among people, like the development of common purposes, shared norms, and expectations.

Material resources.

All cases except Case 3 (a middle school teacher) described 50 minutes of weekly PLC time, with Case 4 describing an additional 50 minutes every other week for collaboration time usually spent on better understanding the Common Core Standards. Case 2 participants noted having a late-start Monday that provided time for meetings, including content, departmental, and grade-level meetings. All cases described using curricular materials like websites to find relevant curricular materials, with Cases 2 and 4 in Sun Valley describing access to a district Google Drive

maintained and updated with curricular materials by math coaches. All cases but Case 3 described accessing mathematics textbooks like Van de Walle (2005) and access to manipulatives. Sun Valley teachers in Cases 2 and 4 were given materials assembled by teacher leaders as part of a district-led effort to understand the Common Core Standards, like district workbooks, end-of-unit assessments, or pacing guides. These materials were among some of the materials housed on the district Google Drive.

Human resources.

Teachers in all cases described attending district trainings for the purpose of better understanding facets of the Common Core Standards. Long Pond Cases 1 and 3 described engaging in trainings geared towards using lesson study to understand the new standards in a cross-site lesson study with one teacher from every grade-level in the district.

Sun Valley participants also engaged in a lesson study at the beginning of the year but discussed some focus on leadership, whereas the Long Pond teachers report it on lesson study. Teachers at Case 1 and 2 described their principal as a resource that provided knowledge and skills about the Common Core Standards and, in the case of Case 1, the knowledge of mathematics and teaching mathematics. The teacher in Case 3 did not mention her principal providing skills or knowledge, and the teachers in Case 4 describing their principal as supportive overall without stating the exchange of particular skills. Teachers at Case 1 and 2, which involve different districts, also both described using TOSA mathematics coaches to learn more about mathematics. Teachers in Cases 3 and 4 did not report working with TOSAs, in fact, the teacher in Case 3 reported skepticism in the TOSA's knowledge about the Common Core

Standards, and questioned what was learned from the TOSA. Cases 1 and 4 discussed fellow colleagues as providing particular qualities, like knowledge about mathematics or sequencing topics, where participants at Case 2 and 3 did not describe many colleagues as resources.

Social resources.

Participants varied in their reports of communities and catalysts that provided material and human resources. Case 1 participants reported many connections to teachers within their grade-level – some of these teachers being Project X participants and some not – and also across grade-levels, especially with those whom participated in Project X. Some mentioned that they could reach out to other teachers at different sites if they needed particular resources.

Participants in Cases 1 and 2 both reported having connections to TOSA coaches and interacted with them when they had questions. For example, teachers at the school site discussed in Case 1 reported collaborating with Kai and Kimmy. And teachers co-planned and co-taught with a TOSA as was the case with Kamille in Case 2. Teachers at Case 1 also reportedly described their relationship to their principal as being a resource for many of their activities, like observing classrooms, supporting collaboration time, sharing articles, and as a source of information in interpreting and applying the Common Core Standards. Some teachers in Case 2 discussed their principal as supportive of teacher collaboration while others did not describe her as supportive.

Thus, there existed social networks for teachers in Cases 1, 2, and 4, and limited networks for Tonya in Case 3 for attracting resources. Case 1 was particularly

well-connected among Project X participants, with a heavy use of their principal as a resource in large part due to his prior job as a middle school mathematics coach. Case 2 had teachers connected to principals and mathematics coaches, and case 4 had teachers well-connected within their own grade level without describing the use of mathematics coaches and their principal serving to help coordinate logistics resulting from their own creations during collaborations (e.g. request and completion of engaging in lesson study as a fifth grade team).

These resources reported in Chapter 4 describe resources that could potentially support lesson study. They also show that not all teachers had access to the same types of resources, with Case 3 teacher reporting few connections to outside resources and people like TOSAs. The analysis also demonstrated that time was necessary usually during school hours or for pay after contracted hours but the type and timing of the time was critical as well.

Analyses showed that teachers described engaging in lesson study in a range of ways, even if they had not completed an “official” round of lesson study. Teachers reported still engaging in some practices of lesson study. There were cases on how teachers continued lesson study.

1. Case 1 involved some teacher participating in a **district-led** effort to continue with lesson study and significant practices of lesson study in PLCs.
2. Case 2 involved some teachers continuing **particular practices of** lesson study but not seeing these as an ‘official cycle’

3. Case 3 involved a teacher **not continuing** lesson study in any practice of lesson study after participating in one district-led lesson study.
4. Case 4 involved some teachers engaging in **site-wide**

Long Pond school district arranged district-led lesson study at the beginning of the year, with Sun Valley committing to put lesson study in their three-year professional development plan and hiring mathematics coaches familiar with lesson study.

Teachers from Case 1, 3, and 4 participated in these efforts.

Case 1 had two PLCs and teachers in these PLCs participated in aspects of lesson study, mostly co-planning, individually teaching, and debriefing with a strong emphasis on students' mathematical thinking. They also reported observing and debriefing but not necessarily co-planned lessons.

In Case 2, teachers report collaborative planning and also one co-planned, observed and debriefed lesson with TOSAs and her grade-level teacher. Though the description might sound like lesson study, she was hesitant to describe it as lesson study. Two had an explicit focus on student thinking.

Case 3 only participated in the district-led lesson study, and otherwise reportedly did not engage in lesson study activities.

Case 4 engaged in all aspects and facilitated site-wide, teacher-led lesson study with a focus on anticipating and responding to student thinking.

Integration, Linkage, and Synergy

I reported on teacher groups and levels of integration, linkage, and synergy among each case in Chapter 5. When taken together with teachers' conceptions of lesson study (Chapter 7) and types of resources (Chapter 4) the factors emerge.

Fourth and fifth GLG groups in Case 1, teachers lacked integration, or trust, shared values, goals, and expectations, and varied with respect to views of professional inquiry and effective teaching. There was also a clear lack of alignment on how teachers wanted to spend their collaboration time. Though individual teachers reported links to other people, resources, and groups outside of their GLG, these connections were not always utilized during collaborations due in part to low integration, indicating low levels of linkage for the fourth GLG.

Despite the alignment of material and human resources, teachers were not supported in engaging in the professional inquiry within grade-level groups at Case 1. Teachers' views of professional inquiry, effective teaching, mathematics, and how they want to spend their collaborative time together did not align among the fourth GLG, and were moderately aligned among the fifth GLG. Some groups, like the fourth grade PLC and Project X PLC, were more successful in attracting other resources through their linkages, or connections to people that attracted resources, than GLGs. Also, most participants were not clear of the district goals or thought they did not align, suggesting low levels of synergy.

Sun Valley's Case 2 showed that alignment of teachers' views of professional inquiry, effective teaching, and how teachers wanted to spend their time mattered. While Anita reported moderate levels of integration with respect to her eighth-grade ELA group, Kamille and Nancy both reported low levels of integration with respect to views of effective teaching (in Kamille's case), unclear views of the goals of group members, and lack of agreement on how to spend collaborative time. Each of the three teachers described using connections to people, resources, and groups outside of their

group, like Kamille utilizing connections to math coaches to engage in a form of lesson study and Nancy turning to TOSA mathematics coach Dianna for help with strategies about questioning students' mathematical thinking. Though Anita's eighth-grade ELA group saw her principal in full support of her group engaging in a collaborative effort like lesson study, Nancy's sixth-grade mathematics group thought the district was "biting off the whole chunk in one mouthful" with Common Core implementation, suggesting low levels of synergy. Kamille's group expressed even more concern about whether the district's view of effective teaching aligned with their view of teaching. Kamille stated that others did not understand her method of teaching, though expressed some hope that the principal was coming to understand a non "direct instruction" approach that focused on mastery of skill. Indeed, Principal Kate's interview suggested that she recently shifted her view of effective teaching to include "inductive" lessons that started with students exploring ideas without being told the "right" way to solve a problem right away. Kamille was also not clear of the district's goals, suggesting another way in which her group had low levels of synergy with the district.

The last PLC in Case 4 in Sun Valley showed high levels of integration, low levels of linkage, and high levels of synergy. The group's view of professional inquiry aligned, with each expressing autonomy in creating their own agendas for collaboration, a desire to learn more about the Common Core Standards through intense lesson planning, and even using lesson study to examine ELA Common Core Standards. There were also integration themes of productive struggle to reconcile differing perspectives among group members as well as a focus on supporting

effective instruction for each student at their site. Their linkage levels were low, with neither participant describing working with a mathematics coach, although Kerry served as a leader of her grade level for Common Core district meetings. These teachers did not turn to the principals for human resources and instead asked her to coordinate material resources such as release time to engage in lesson study. They found human resources within each other's knowledge and skill and were supported with time to work with their own group, which resulted in high integration. Due in part to their intense focus on designing and testing new lessons through the use of lesson study (and not due to a lack of desire in reaching out), they did not have the time to collaborate with others.

Levels of synergy were low with respect to each of the four groups in Case 1 and the larger context of the district. Most teachers, like Carmen and Jimmy, expressed that they did not know the goals of the district beyond understanding the Common Core Standards. Some teachers like Mia expressed that they saw the district as assessment driven, and not in support of teachers' methods of professional inquiry, like observing teachers or engaging in their own inquiries like with lesson study. Others like Bertha were waiting for the district to suggest a clear direction for teacher collaboration. Interviews with TOSA Kimmy suggested that Long Pond school district provided material and human resources for a two-day lesson study cycle, and required one teacher at every grade in the site. As an example, the district provided a district-led lesson study training to teacher representatives from each grade-level across the site with the goal of having these teachers bring lesson study back to their individual sites. Fifth-grade teacher Mia noted that she was waiting for follow-up of the district-

led training at her individual site. Kimmy reflected that she would have liked to have implemented the district-led effort differently, and only worked with teachers who had a desire to engage in lesson study.

High levels of synergy in Case 4 contrasted with other teachers waiting to hear what the district recommended. In Case 4, teachers described creating their own agendas for their PLCs. They also volunteered to engage in a lesson study for their grade-level, and convinced each other, with the support of the rest of the school's leadership team, that the site should engage in a site-wide lesson study. They described serving as human resources to the principal, helping her to learn about how lesson study could be used to create and co-teach a lesson that targeted ELA standards while using the discipline of science to serve as content of the lesson. This contrasts low levels of autonomy in Case 1 when Bertha stated about the lack of clarity of district goals and ways to reach goals,

I think they're kind of just trying things, which is, you know, that's normal. They're just, okay, what if we do this? It doesn't work and then nothing happens for a long time. And we're left like, Okay now what do we do? You told us to do this and now what?

Mia also described a mixed stance with autonomy at Case 1, suggesting that a lack of leadership with the autonomy those at her site had. Mia noted that agendas were not created by the administration and consequently there was more freedom at this site to discuss what teachers wanted to talk about. "But in that freedom, sometimes, you know, people. It could go either way. Freedom could be a good thing or a bad thing." With Long Pond's method of injecting material and human resources, in the form of three hours paid collaboration time and a district-led lesson study training that was to

spread back to the lesson study groups' individual sites, it is reasonable that Case 1 teachers would wait to see what the district would suggest given low levels of autonomy. Thus, the presence of autonomy with Don and Kerry's fifth-grade group suggested high levels of synergy.

Perhaps the most unsupported case rested with Tonya in Case 3. I found low levels of integration, linkage, and synergy with this Long Pond middle school teacher. Tonya described being in a "vacuum" with the lack of collaboration at her site with her fellow seventh-grade mathematics teacher, suggesting low linkage. Though she and her fellow teacher shared the goal of improving their school, they had not discussed more explicit goals for mathematics. When it came to alignment of her group's goals to the district, Tonya reported skepticism of the district's implementation plan. She described frustration while working with a coach to understand what was an essential question, and expressed doubt that the new standards would even improve student learning. Tonya also found the district-led lesson study training at the beginning of the year frustrating when they left it up to these teachers to continue lesson study at her site since no teacher expressed interest in engaging in lesson study. The lack of alignment of goals about professional inquiry, few connections to resources, people, or groups outside of her mathematics GLG, and skepticism about the district's implementation of the Common Core Standards combine to Tonya's limited reports of other resources in Chapter 4 show that Tonya had access to few material, human, and social resources.

It should be noted that all three principals reported enthusiastic support with their teachers engaging in lesson study. All principals were situated within districts

that attempted to align some material and human resources. Each principal noted the importance of ideas for teacher collaboration originating by the teachers. In the site-wide engagement in lesson study found in Case 4, Principal Paula described that the idea for doing this originated with Kerry, a former Project X teacher with two teammates who both had experienced lesson study during grants.

Varying Conceptions of Lesson Study

When applying the sustainability framework, it became clear that teachers held different conceptions of the purpose of lesson study.

Although participants across all cases mostly reported a similar *structure* to lesson study (Bertha, Anita, and Nancy did not describe the optional modify and reteach component, and Bertha did not specify investigation component), teachers' conceptions as to the *purpose* or usefulness of lesson study varied. In Case 1, teachers saw lesson study as useful for developing pedagogy, learning mathematics, focusing on student thinking, using it as a lens, and for understanding the Common Core Standards. In Case 2, teachers reported the uses of lesson study as developing pedagogy and understanding the Common Core Standards. In Case 4, teachers reported lesson study as useful for developing pedagogy, improving lessons, benefiting and highlighting student learning, and understanding the Common Core Standards. Tonya in Case 3, however, only reported that lesson study was useful for creating good lessons.

Thus, all cases but Case 3 reported that lesson study was useful for developing pedagogy and understanding the Common Core Standards. Though both Cases 3 and 4 referred to lesson study as useful for lessons, Case 3 participant saw the main purpose

as creating good lessons and saw the challenges noted with convincing others at her site to engage with her. Teachers in Case 1 emphasized the potential for learning mathematics by engaging in lesson study. Teachers in Cases 1 and 4 emphasized the role lesson study played with respect to student thinking – in Case 1, Jimmy reported its uses for observing student thinking while in Case 4 Kerry reported lesson study's benefit to student thinking due to well-designed and collaboratively created lessons that focused on anticipating student thinking.

Conclusion

This dissertation has provided an understanding of how researchers and educators in mathematics education can support mathematics teachers in continuing to engage in lesson study and other professional development efforts. By providing answers to practices of lesson study that have sustained and examining social resources like teachers' conceptions of lesson study and factors that both supported and hindered teachers' ability to continue to engage in lesson study, I have responded to what Lewis & Perry (2014) call researchers to do: "to think in fundamentally new ways about the scaling-up of educational improvement" (p. 36).

Chapters 4-7 presented results of grounded theory, social network theory, and multi-case study analyses using a modified sustainability framework of integration, linkage, and synergy. The results provided in Chapter 4 provided evidence of varying levels of support across four cases. These results established that examining social resources in greater depth was appropriate for investigating supportive and constraining factors for continuing lesson study. The results presented in Chapter 5 established the presence of different groups of teachers (Kramer, 2003) with varying

levels of integration, linkage, and synergy across the four cases. These results allowed for a greater understanding of the broad concept of social resources via four contrasting cases and also provided reasons to explain the other two research questions. In general, PLCs showed higher levels of integration, linkage, and synergy, while GLGs showed lower levels of integration, linkage, and synergy (Gamoran et. al, 2003). This chapter gave an initial answer to research question (1).

Chapter 6 results demonstrated the aspects of lesson study reported to have continued within teachers' reported activities. Each of the ways of continuing lesson study were supported and constrained by both the resources described in Chapter 4 and clearly related to the levels of integration, linkage, and synergy. The case that did not continue lesson study at a site showed few material and human resources, and also low levels of integration, linkage, and synergy. Alternatively, those continuing aspects of lesson study showed high levels of integration, linkage, and synergy with respect to PLC groups in Case 1 and moderate levels in Case 2. The case that engaged in a voluntary teacher-led lesson study showed high levels of integration, moderate levels of linkage, and high levels of synergy, with access to material and human resources when needed. These results answered research question (2).

Chapter 7 results furthered an important theme of integration – namely, teachers' conceptions of lesson study – and demonstrated that teachers' conceptions of lesson study varied from the belief that engaging in lesson study affords well-designed research lessons (Case 3) to lesson study as a vehicle for developing pedagogy (Cases 1, 2, and 4), better understanding the Common Core Standards (Cases 1, 2, and 4), learning mathematics (Case 1), and focusing on students' thinking (Cases 1 and 4). As

such, this chapter added another dimension to answer to research question (1) and also answered research question (3).

Resources matter for continuing practices. Principals can align material resources such as time and curricular materials to facilitate collaboration. Teachers such as Tonya report a deficit of resources. Within an integrated group the resources can be used to generate new human and social resources. Principals can also constrain sustained practices as in Case 1 where some resources are limited like arranged time for within grade collaboration. The research confirms that integrated, linked communities can sustain practices. Groups with low integration but with linked individuals can sustain at some level of practice.

Visions of lesson study also shape activities. The richest well-developed conceptions of lesson study enabled visions of how lesson study was usefully applied to many things. If lesson study perceptions were more limited or extremely limited, as in making 'perfect' lessons) it was challenging to align or attract resources to continue lesson study practices. Teachers who saw lesson study as useful for understanding Common Core Standards would support continuing lesson study.

Additionally, those with autonomy and a culture of collaboration were likely to continue lesson study, as seen in Case 4. The challenge of a persistent culture of teaching as isolated rather than a culture of deprivitization of practice constrained some teachers in Case 1 and Tonya in Case 3.

Limitations of Study

It is important to recognize the limitations of any study to qualify conclusions and suggest changes for future research. First, this study was not intended to be a

longitudinal or evaluative study on the effectiveness of lesson study as a form of professional development. Additional data collection cycles could have spoken to the development of such factors rather than a snap-shot as this study provided. Second, this qualitative study was not intended to create generalizations from large number of participants for all contexts, like a quantitative study might. Instead, this exploratory study sought to better understand the experiences of a unique group of teachers – a subset of approximately 75 teachers who engaged in intense cycles of lesson study multiple times a year for three years – to investigate and provide insight into what might support teachers across two districts in continuing lesson study. It is important to understand the peculiar timing of the unveiling of Common Core Standards. Districts may have been freer with resources. Teachers may have felt more constrained. It made perceptions of lesson study more acute. Studying additional teachers could provide additional insights into the complexities of resources that support teacher collaboration, and the integration, linkage, and synergy of both informal and formal groups within educational contexts.

Discussion of Contributions of the Study

My work contributes a mixed methods study that examines in depth what might be needed to sustain lesson study efforts of teachers who recently engaged in lesson study. It contributes to the field of mathematics education in a number of ways. First, this study directly contributes to a growing number of studies on mathematics lesson study with practicing teachers in the United States. This addresses the call for more research on lesson study to move the mathematics education field forward (Fernandez, 2005; Lewis, Perry & Murata, 2006; Murata, 2011). Particularly, Murata

(2011) calls for the need to understand how aspects of lesson study could be modified while maintaining its key features to better understand educational systems as they are and the cultural values and beliefs supporting it. This multi-case study analyses responds to this call by giving empirical evidence on how to support lesson study so that teachers can continue to improve their practice within U.S. educational systems.

Second, this study contributes to better understanding how to support mathematics teachers in engaging in professional development efforts after external funding ended. The field of mathematics education is growing in its attention to issues of policy, like scale (e.g. Coburn, 2006) and understanding institutional settings within which teachers lives' are situated (Cobb et. all, 2003). This study brings mathematics education closer to better understanding factors that supported and constrained teachers in sustaining lesson study. Empirical evidence suggests that aligning views of professional inquiry, effective teaching, and how to spend collaboration time are important social resources for supporting lesson study. Additionally, teachers' conceptions of the use of lesson study can support or constrain teachers' ability to continue with lesson study.

This study also contributes to the field empirical evidence for reimagining the concept of sustainability. Some use the word *sustainability* to refer to an effort continuing over time. Yet others recognize the need for it to be generative, that is, to change and adapt within the context. This study provides empirical evidence of the importance of attending to not *whether* an effort continued with but to examine how the effort *changed* to adapt to the current context and thus regenerate.

Third, this study considered the methodological contribution of using social network analyses to attend to mathematics teachers' access to resources and the networks of which they are members. As researchers in lesson study continue to better collective understandings of the mechanisms by which teachers learn through lesson study and updating iterative cycles of design research (Lewis, Murata, & Perry, 2006), social network theory could prove to play an important role in understanding development over time. Using social network theory shows promise in supporting and better understanding teacher-led lesson through its focus on connections to resources, people, and other groups.

Recommendations for Teachers, Principals, Districts, and Professional Developers

An important implication from this study lies in its potential to direct teachers, districts, and professional developers attention to issues that could support teachers in continuing lesson study.

First, teachers' shared views on professional inquiry, visions of effective teaching and in particular, purposes of lesson study and subsequent view of resources and goal paths were demonstrated to be important for productive teacher collaboration. Conversely, a lack of agreement on how to spend time, general lack of alignment of views of effective teaching, few connections to resources outside of a teacher's group, and limited opportunities to engage in collaborative activities were shown to contribute to low levels of integration and linkage.

Consequently, principals may take note that it is not enough to provide material and human resources to support lesson study. In addition to providing these

resources, there needs to be attention to social resources like trust, shared values, norms, and expectations, among teachers and the larger setting in which they work, including principals and the district. Principals play an important role in communicating the district's goals and aligning resources for support. The contrasting experiences of Case 1 and Case 4 point to the need to attend to teacher autonomy and leadership. Professional developers, such as those that facilitate lesson study, must take heed in providing clear examples of what lesson study is (and is not) with particular attention paid to the focus of lesson study on making explicit students' mathematical thinking, rather than critiquing teachers' mathematical instruction.

District settings are complex, with no such thing as the "right" way to work with teachers since each district's needs vary in important ways. Yet by attending to social resources, especially teachers' conceptions of lesson study, deprivitization of practice, and developing a true culture of collaboration, teachers and districts could together provide better support for teachers continuing to engage in lesson study.

Future Research

This study sparked interest in and demonstrated the need of more research on a number of areas within mathematics teacher professional development.

First, it is clear that issues of power and authority were present in teachers' professional lives, and that they played a role in developing and shaping teachers' experiences. In listening to teacher interviews, I became aware of a classification of teachers and workers – new teachers, veteran teachers, teachers who were also mathematics coaches, teachers who engaged in facilitation of some district-provided

training, among others. Carmen, Bertha, and Mia each eluded to this theme. Carmen stated,

There are some third grade teachers who come and talk to me, and a couple of second grade teachers who come and they'll like ask questions. Um, so like they know that I'm here and I'm a resource, and I like that. And at the same time I don't like that. It's like a double edged sword because I told my principal, and I've told Ron. Like, yes they can come and I will help them as much as I can. But then at the same time it just fuels the fire of, I think I'm better than them. Which is not what I think at all. But that's like, 'Oh, she thinks she's so much better than us. Look at, she's trying to, you know, work with this grade level now.' Or, 'she's trying to tell them...' like I'm persuading them somehow to do Common Core. And I feel like, it's at one point I said, you know I am not Common Core. I am me, and I just happen to believe, like, fundamentally in a lot of the, the tenets of Common Core. But I didn't create it. It's not my thing, it's not my baby. But when you have teachers who are so resistant and so afraid of change, it's like they start going, you are with us and you are against us. And if you're against them, and I'm like, I'm not against you! I just, I've always taught differently.

Similarly, when Bertha described an uncomfortable part of lesson study, she targeted the fact that some teachers might compare Bertha's teaching of a lesson to a lesson that did not go as well.

I even felt uncomfortable. Like, you're saying a whole bunch of positive things that went on. Not like everything was, you know. But, 'Oh, you know, your kids did this and your kids did that and what'd you guys think?' And then I always felt like, 'Oh please don't say anything more.' Because I don't want anybody to feel like I'm better. Because I'm not. I'm still even learning! You know? It just depends, it just depends on your strengths. And I didn't like that. On either end. That's just personal. I wouldn't like to be on the other end where my kids didn't do so well. Cause I, I wouldn't help but just to think, okay there's something wrong with me, I don't know how to teach. And then if I was at the other end, too, like, 'Oh you know, your kids did so well. And did you notice what they did?' I wouldn't, I don't want to be like, 'No! Stop talking

about me. I don't want to make the other people feel bad.' So, that was weird. Having the same lesson. And I get why they did it. They just, how, I get why they did it, I just don't like them.

Along similar lines, Mia discussed that some teachers, even those she considered close friends, were hesitant that Mia could provide knowledge and skill about teaching.

Or sometimes people saying, 'Well, it's those who did the project.' Or it's, 'Oh, you worked with Kimmy again. Oh you went to [county office of education] with the principal. Oh, and so you're telling me now what to do?' I did that a little bit through our old, my old site, we were leading staff developments. And even people who were my friends, I could see [them think], 'What do you know about this that I don't?' Or veteran teachers listening to younger voices. Or people thinking, 'You don't know what's going on in my classroom. How are you telling me that you do?' So this, the culture of accepting what the goals are of the lesson study, and just coming together with groups. Like the gentleness in which you put that together, I guess. So. It'll take strong people.

Related to other teachers' questioning the authority of fellow teachers was the qualification of some teachers' talents. Some teachers did not feel comfortable when other teachers made note of how much knowledge of the new Common Core Standards, for instance, that some teachers had. Carmen reported that,

You know, people say, 'Oh you totally get Common Core!' No, I don't. I don't even closely, like I. There's so many things I, I still think. My understanding is not, you know, Phil Darro's understanding of Common Core at this point. But I'm, I might be just a little bit further ahead just because I've been exposed to it for a few more years. And I've been exposed to conversations, where people have had these Common Core like conversations.

How does a culture of collaboration change this power tension?

Related to understanding power dynamics among teachers is to understand how principals, in particular, navigate their power while working with lesson study teachers. All three principals interviewed for this study recognized the importance of

ideas for professional development originating from teachers. For a principal to mandate that lesson study be completed would not be an acceptable action. But if an idea originated from a teacher, s/he could then support her/his teachers in engaging in professional pursuits like lesson study. Additionally, since lesson study is a teacher-led effort, it would seem inappropriate to have its future completely controlled by administration.

This brought me to an interesting conundrum as a researcher. If lesson study needed the support of principals and districts, how could administrators help teachers engage in lesson study a productive way that respects the goals, experiences, and efforts of teachers? For example, when two teachers have experienced lesson study in a grade-level, and two have not, what role could the principal play to support teachers in their professional development? Similarly, how could teachers change their goals and perspectives to see the importance of collaboration and continual effort towards improvement if they remain in culture that does not encourage or reward these stances? These questions suggest the importance of better understanding the balance of authority between teachers and the institutional setting within which they work to continue to study how to support teachers in continuing to engage in lesson study.

Second, I also became intrigued about the ways in which teachers came to understand the goals of their district, which is a lived organization comprised of a number of different people with different sets of expertise and agendas. What messages were communicated by the district, both directly and indirectly? How do teachers get a sense of these messages, and how do these interpretations affect their work? Research on social network theory has been used to understand how district

policy influences teachers' social networks during a scale-up of mathematics curriculum (Coburn & Russell, 2008). Coburn and Russell (2008) found that policy affected whom teachers sought to discuss mathematics instruction, with variations in the nature and quality of discussions. They also found that school leaders affected patterns of interaction as they mediated district policy. Understanding how lesson study practitioners make meaning of district messages and policies could contribute to better understanding levels of synergy among groups of teachers and the district.

Third, studying the sustainability of an endeavor like lesson study demonstrated the need to attend to what I call *beginability*, or re-implementing lesson study by inviting newcomers to join old-timers (Lave & Wenger, 1998) in an activity where conceptions of the purpose and nature of lesson study might vary across individuals. How does sustaining efforts with old-timers combine with efforts to implement lesson study with newcomers? With teachers often changing grade-level and sites and sometimes leaving the profession, lesson study cannot continue with old-timers if newcomers are not considered.

Indeed, reflections with Kimmy on the district-led effort in Long Pond suggested that she would sustain and implement lesson study differently if she could do it again. Instead of engaging a person from each grade level at each site as others in the district directed her to do, Kimmy reflected that she would start with smaller groups of teachers who had a desire and interest in lesson study to develop leaders. Though it might be a slower process, she reasoned that more teachers could eventually see the benefits from it without being overwhelmed at a new experience. Instead, Kimmy reported that there was some backlash, and consequently the district "backing

off’ rather than continue to improve the process. “How you implement this is so important. I knew it before. But that just proved it to me,” Kimmy reflected. Thus, understanding how to allow opportunities for teachers who have never experienced lesson study to join more seasoned lesson study teachers is an important issue both for the theoretical purpose of better understanding sustained lesson study efforts and the practical purpose of implementing and continuing lesson study with practicing teachers.

Fourth, participation in lesson study provides experience that allow participants to engage in potentially rich conversations about teaching and learning mathematics. I was originally drawn to researching lesson study when I discovered rich conversations about teaching and learning mathematics occurring among teachers during my work as a research assistant on the CaMSP project. Consequently, I would like to study the conversations that lesson study participants have, the arguments they create when collaborating together, and the nuanced insights into mathematical thinking learned. This could provide rich insight into the mechanisms by which teachers learn about teaching and learning in lesson study (Lewis, Perry, & Murata, 2006).

Lastly, I am interested in understanding how to bring prospective teachers together with practicing teachers through the vehicle of lesson study. One teacher, Mia, suggested that lesson study be part of a credential student’s experience.

They don't teach it to you in credential programs most times. Very seldom do you have someone talk about... Well, I mean, you *talk* about it all the time. You talk about those researchers, and you talk

about those theories, and you talk about the conceptual knowledge. Those are all there. But you don't see really how it applies to the classroom. So this is in my mind, I mean, lesson study should be done as part of your student teaching to really see what we are talking about when you are developing a practicum.

Engaging prospective teachers in experiences where they work with more knowledgeable others could help these students learn about the practice of teaching. Similarly, practicing teachers could learn from prospective teachers engaging in mathematics content courses at a university and recharge, update, and deepen their knowledge about current issues that are of interest to both parties.

Appendix 1: End-of-Grant Survey May 2013

Name: _____ Project X
Grade _____, School _____ at (circle) LPSD / SVSD

Lesson Study Sustainability Questions

We would love your feedback on your experience with this grant and your plans for future.

1. Recall the four critical pieces of lesson study – goal setting/curriculum & standard study/lesson plan writing, lesson observation, and debriefing.
 - A. Who might you be able to work with to continue your collaborative lesson study work? Please name the teachers, his or her grade level, experience with lesson study, school and school district.
 - B. How much time do you imagine meeting for each piece of lesson study - planning, observing and debriefing - with these teachers? (e.g. 1 time/week for planning, twice/semester for observing and debriefing.)
 - C. Describe your general game plan for continuing to implement lesson study for the 2013-14 school year. What are you committing to do?
 - D. As Susan and Bridget follow-up with you on your progress, are you willing (check all that apply):
 - o to be interviewed ?
 - o to be observed planning team’s lesson ?
 - o to be observed teaching team’s lesson ?
2. How can PROJECT X assist you with your implementation plan?
3.
 - A. When does your school year start? (Approximate dates okay.)
 - B. When do you imagine your first meeting to take place? (Approximate dates okay.)
4. If you have any questions/comments for Susan or Bridget, please feel free to write them here.

Appendix 2: Online Survey

Thank you for participating in our Fall 2013 Lesson Study Survey. We are interested in hearing from people continuing and discontinuing lesson study. We appreciate your time spent answering all of these questions completely. If you have any questions, please feel free to contact Bridget at druken@rohan.sdsu.edu.

Susan Nickerson & Bridget Druken, Sun University

Category	Question
Background	<p>Q1: Please state your name, school and grade level/subject currently teaching for the 2013--2014 school year.</p> <p style="padding-left: 40px;">Name (first and last)</p> <p style="padding-left: 40px;">School</p> <p style="padding-left: 40px;">Grade Level / Subject</p>
Lesson Study Continued?	<p>Q2: Have you continued with lesson study at your site (with or without Project X members)?</p> <p style="padding-left: 40px;">Yes and we have completed at least one round of lesson study.</p> <p style="padding-left: 40px;">Yes and we have not completed a round of lesson study.</p> <p style="padding-left: 40px;">No but I plan to.</p> <p style="padding-left: 40px;">No and I do not plan to.</p> <p style="padding-left: 40px;">Other (please specify)</p>
Lesson Study Continued?	<p>Q3: If yes, how many members in your current lesson study team are teachers who participated in the Project X three-year grant between Long Pond School District, Sun Valley School District and Sun University? How many are teachers who did not participate in Project X?</p> <p style="padding-left: 80px;"># of team members Former Project X Teacher</p> <p style="padding-left: 80px;"># of team members New Teachers (non-Project X)</p>
Factors Supporting & Hindering	<p>Q4: What statements characterize the factors that support or hinder lesson study (select all that apply):</p> <p style="padding-left: 40px;">My school or district has arranged time for us to collaborate for lesson study.</p> <p style="padding-left: 40px;">My school or district has arranged time for us to collaborate but it is not geared for lesson study.</p> <p style="padding-left: 40px;">Resources have been provided but the culture hasn't yet been established.</p> <p style="padding-left: 40px;">We arrange time after school to collaborate with others for lesson study.</p>

	<p>We utilize social media to virtually collaborate with others for lesson study.</p> <p>We are interested but do not have the resources to meet.</p> <p>We can collaboratively plan but do not yet have a means to observe .</p> <p>We have a means of planning and observation but need other support.</p> <p>Other (please specify)</p>
School-wide Vision	<p>Q5: School-wide Vision. On a scale from 1 = strongly disagree to 4 = strongly agree, please rate the following:</p> <p>Teachers in this school exhibit a focused commitment to student learning in mathematics and science.</p> <p>A vision for student learning in mathematics and science is shared by most staff in this school.</p>
Support for Innovation	<p>Q6: Support for Innovation. On a scale from 1 = strongly disagree to 4 = strongly agree, please rate the following:</p> <p>In this school I am encouraged to experiment with my teaching.</p> <p>Teachers in this school are continually learning and seeking new ideas.</p>
Admin Support	<p>Q7: Administrative Support for Teaching. On a scale from 1 = no help to 6 = extremely helpful, to what extent has each of the following people helped you improve your teaching or solve an instructional or class management problem?</p> <p>Principal or head of this school.</p> <p>Other teachers at this school.</p> <p>Other teachers in this district.</p>
Professional Development Climate	<p>Q8: Professional Development Climate. On a scale from 0 = rarely or never occurs to 3 = always occurs, please rate the following:</p> <p>When my school initiates a change (e.g., decision making, curriculum), it supports the change with professional development opportunities.</p> <p>Teachers are left completely on their own to seek out professional development opportunities.</p> <p>Teachers here help one another put new ideas from professional development to use.</p> <p>Most professional development in this school enables us to build on our teaching experiences.</p> <p>This school draws upon teachers' knowledge and practical experience as resources for professional</p>

	<p>development. The school principal encourages teachers to participate in professional development.</p>
Invitation for Interview	<p>Q9: Would you be interested in participating in an interview to elaborate on some of your answers? We would compensate you for your time with a \$30 Amazon gift card.</p>
Final Comments	<p>Q10: If you have anything else you would like to share with us, please provide your comments in the space below. We appreciate your responses.</p> <p>Thank you for taking our survey. For participating in our survey, we would like to send you an Amazon gift card. Please write the address to which we should send your gift card (school or home).</p> <p>Comments: Address to send Gift Card:</p>

Appendix 3: Semi-structured Sustainability Interview Guide, Teacher

Thank you (Participant's name) for taking the time to participate in this interview. We are interested in hearing your experiences after the grant has ended, who you are working with, and what sorts of activities you do with them.

Category	Question
Background	<p>First we have some questions about your experiences as a teacher after participating in the Project X grant.</p> <p>Q: Are you still working at the same school where you were working during PA?</p> <ul style="list-style-type: none"> - Are you still teaching at the same grade level? - If not, were there district changes that affected your placement?
	<p>Q: Are you working with some of the teachers from PA?</p> <ul style="list-style-type: none"> - If yes, are these teachers at the same site or teachers site?
Groups	<p>Q: Is there a community or group of teachers with whom you collaborate?</p> <ul style="list-style-type: none"> -Would you say this group was formally or informally arranged? - How long has this group been going?
	<p>Q: With respect to the first group you told me about, what activities do you engage in with your group?</p> <p>Would you say you do lesson study with this group?</p> <p>How often do you meet?</p>
	<p>Q: Are there any other groups with whom you work?</p> <ul style="list-style-type: none"> - Would you say this group was formally or informally arranged? - How long has this group been going?
	<p>Q: With respect to the second group you told me about, what activities do you engage in with your group?</p> <p>Would you say you do lesson study with this group?</p> <p>How often do you meet?</p> <p>(repeat for each group)</p>
	<p>Q: Have you completed a round of lesson study since the grant ended?</p>
Resources	<p>Q: What sorts of resources does your school give to support your (insert group name)?</p> <ul style="list-style-type: none"> -In addition to (support: math coach), (support: PE teacher), etc., were there other resources that your school/district provided that supported your group's work at lesson study?

Category	Question
	Q: (If they have not specified and done lesson study) What resources were for lesson study activities?
	Q: (If they have not specified and not done lesson study) What resources would support your lesson study activities?
Lesson Study	Q: Can you briefly describe what goes on during a lesson study round? - If they say, 'we plan a lesson', ask, how did you arrange time to plan? How often? - If they say, 'we do an observation', ask, how did you arrange time to observe? How often? -If they say, 'we debrief', ask, how did you arrange time to observe? How often?
	Q: (If they have difficulty with something) Would you have liked to have done lesson study? - (If they say yes) Were there obstacles to observing (or planning, or debriefing)?
	Q: Did you teach the research lesson during lesson study? How did your group decide that? (Optional: What is it like to have teachers observe your practice?)
Linkage	Q: Do you feel like your (insert group name) has connections to resources/people/groups outside of your PLC?
Integration	I'm going to ask you some questions about your (insert group name) and school site now. Q: Do you feel like the goals of your (insert group name) are aligned?
	Q: Do you feel like your (insert group name) has shared values about what constitutes effective teaching?
	Q: Do you feel like your (insert group name)'s goals are aligned with Project X PD goals?
Synergy	Q: Do you feel like your (insert group name)'s goals are aligned to the goals of your district?
Lesson study	Q: If you were to do lesson study again, would you change anything from the way it was done in Project X? (or) Q: If you did lesson study, did you change anything from the way it was done in Project X?
	Q: What problem is your group trying to solve as you try to go forward with lesson study?

Category	Question
Synergy	Q: Do you think lesson study is or would be useful for figuring out (particular aspect of) the CCSS-M? Why or why not?

Appendix 4: Semi-structured Sustainability Interview Guide, Principal

Thank you (Participant's name) for taking the time to participate in this interview. We are interested in teacher collaboration and the levels of support at your site, in particular, after the grant goes away.

Category	Question
Background	Q: Are there groups of teachers that work together with other teachers/staff at your site?
	Q: What does that teacher collaboration look like?
	Q: What role do you play as the principal to these collaborations at your site?
	Q: How would you describe what effective teaching for mathematics looks like at your site?
Resources	Q: What sorts of resources does the district give you to support teacher collaboration?
	Q: What about in general (e.g. To support <i>any</i> teacher related activity, not just collaboration)?
	Q: What sorts of resources do you provide to support teacher collaboration? - (If describing only monetary) Some principals have talked about covering classes if short of money for a research lesson.
PD	Q: Could you describe the way you think about professional development (PD) at your site?
	Q: What are your goals for teachers at your site? How is this communicated among teachers at your site?
Lesson Study	Q: Are you familiar with lesson study as a form of professional development for teachers?
	Q: What do you think lesson study is useful for?
	Q: What sorts of resources would support lesson study at your site?
CCSS	Q: Has the implementation of the Common Core State Standards (CCSS) affected how you think about teacher collaboration? If so, could you describe it. If not, what has remained the same?

References

- Akiba, M. (in press). Traveling teacher professional development model: Local interpretation and adaptation of lesson study in the U.S. In F. Astiz, & M. Akiba (Eds.), *The global and the local: New perspectives in comparative education*. Rotterdam, the Netherlands: Sense Publishers.
- Akiba, A. M., Howard, C., Wilkinson, B., & Whitacre, I. (2015). Lesson study policy and practice in Florida: 2014 findings from a statewide district survey. Tallahassee, FL: Florida State University.
- Akiba, M., & Wilkinson, B. (2014). Adopting an international innovation for teacher professional development: State and district approaches to lesson study in Florida. Presented at the American Educational Research Association (AERA), Annual Meeting in Philadelphia, PA.
- Alston, A. S., Pedrick, L., Morris, K. P., & Basu, R. (2011). Lesson Study as a Tool for Developing Teachers' Close Attention to Students' Mathematical Thinking. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 135–151). Springer Netherlands.
- Anderson, C. (2003). How can schools support teaching for understanding in mathematics and science? In Gamoran, A., Anderson, C. W., Quiroz, P. A., Secada, W. G., Williams, T., & Ashmann, S. (2003). *Transforming Teaching in Math and Science: How Schools and Districts Can Support Change* (Sociology of Education Series). Teachers College Press.
- Ball, D.L., Thames, M.H., & Phelps, G. (2008). Content knowledge for teaching: what makes it special? *Journal of Teacher Education*, 59(5), 389-407.
- Barriball, K. & While, A. Collecting data using a semi-structured interview: A discussion paper. *Journal of Advanced Nursing*.19, 328-335.
- Beijaard, D., Meijer, P., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and Teacher Education*, 20, 107–128.
- Bernard, H. R. (2006). *Research Methods in Anthropology: Qualitative and Quantitative Approaches* (Fourth Edition edition). Lanham, MD: AltaMira Press.
- Bishop, A. J. (1976). Decision-making, the intervening variable. *Educational Studies in Mathematics*, 7(1-2), 41–47.
- Boaler, J. (1998). Open and closed mathematics: Student experiences and understandings. *Journal for Research in Mathematics Education*, 29, 41-62.

- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18, 32-41.
- Burroughs, E.A., & Luebeck, J.L. (2010). Pre-service teachers in mathematics lesson study. *TMME*, 7(2&3), 391-400.
- California Department of Education (2014). <http://dq.cde.ca.gov>. Retrieved on January 13, 2015.
- Carolan, B.V. (2013). *Social Network Analysis and Education: Theory, Methods & Applications* (1 edition.). Los Angeles: SAGE Publications, Inc.
- Cobb, P., & Bowers, J. (1999). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher*, 28(2), 4–15.
- Cobb, P., McClain, K., Lamberg, T. de S., & Dean, C. (2003). Situating teachers' instructional practices in the institutional setting of the school and district. *Educational Researcher*, 32(6), 13–24.
- Cobb, P. & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, 31(3/4), 175-190.
- Cobb, P., Zhao, Q., & Dean, C. (2009). Conducting design experiments to support teachers' learning: A reflection from the field. *Journal of the Learning Sciences*, 18(2), 165–199.
- Common Core State Standards (CCSS) (2010), “Common core state standards for mathematics”, available at: <http://www.corestandards.org/math> (accessed January 10, 2014).
- Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, 13(1), 3–21.
- Daly, A. J. (2010). *Social Network Theory and Educational Change*. Cambridge, Mass: Harvard Education Press.
- Dean, C. & McClain, K. (2006, April). Situating the emergence of a professional teaching community within the institutional context. Paper presented at the annual meeting of AERA.
- de Freitas, E., & Zolkower, B. (2011). Developing teacher capacity to explore non-routine problems through a focus on the social semiotics of mathematics classroom discourse. *Research in Mathematics Education*, 13(3), 229–247.

- Dede, Y. (2013). Examining the underlying values of Turkish and German mathematics teachers' decision making processes in group studies. *Educational Sciences: Theory & Practice*, 13(1), 690–706.
- DuFour, R. (2004). What is a “professional learning community”? *Educational Researcher*, 61(8), 6–11.
- Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2011). *Writing Ethnographic Fieldnotes, Second Edition* (Second Edition edition). Chicago: University Of Chicago Press.
- Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education*, 88(6), 915–933.
- Fernandez, C. (2005). Lesson study: A means for elementary teachers to develop the knowledge of mathematics needed for reform-minded teaching? *Mathematical Thinking and Learning*, 7(4), 265-289.
- Fernandez, C., & Yoshida, M. (2004). *Lesson Study: A Japanese Approach to Improving Mathematics Teaching and Learning (Studies in Mathematical Thinking and Learning)*. Routledge.
- Forman, E. (2003). A sociocultural approach to mathematics reform: Speaking, inscribing, and doing mathematics within communities of practice. In J. Kilpatrick, W. G. Martin, & D. Schifter (Eds.), *A research companion to principles and standards for school mathematics* (pp. 333-352). Reston, VA: NCTM.
- Forman, E., Larreamendy-Joerns, J., Stein, M., & Brown, C. (1998). “You're going to want to find out which and prove it”: Collective argumentation in a mathematics classroom. *Learning and Instruction*, 8(6), 527-548.
- Franke, M. L., Carpenter, T. P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal*, 38(3), 653–689.
- Gamoran, A. (2003). Access to materials. In *Transforming Teaching in Math and Science: How Schools and Districts Can Support Change* (pp. 65–86). New York, NY: Teachers College Press.
- Gamoran, A., & Anderson, C. (2003). A dynamic model of organizational support. In Gamoran, A., Anderson, C. W., Quiroz, P. A., Secada, W. G., Williams, T., & Ashmann, S. (2003). *Transforming Teaching in Math and Science: How*

Schools and Districts Can Support Change. Teachers College Press.

- Gamoran, A., Anderson, C., & Williams (2003). Sustaining teaching for understanding in mathematics and science. In Gamoran, A., Anderson, C. W., Quiroz, P. A., Secada, W. G., Williams, T., & Ashmann, S. (2003). *Transforming Teaching in Math and Science: How Schools and Districts Can Support Change*. Teachers College Press.
- Gamoran, A., Anderson, C. W., Quiroz, P. A., Secada, W. G., Williams, T., & Ashmann, S. (2003). *Transforming Teaching in Math and Science: How Schools and Districts Can Support Change*. Teachers College Press.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. *Review of Research in E*, 25, 99–125.
- Gee, J. P., Michaels, S., O'Connor, M. C. (1992). Discourse analysis. In M. D. Lecompte, W. L. Milroy, & J. Preissle (Eds.), *The handbook of qualitative research in education*. London, UK: Academic Press.
- Gero, G. (2015). The prospects of lesson study in the US: Teacher support and comfort within a district culture of control. *International Journal of Lesson and Learning Studies*, 1, 4-25.
- Giles, C., & Hargreaves, A. (2006). The Sustainability of Innovative Schools as Learning Organizations and Professional Learning Communities During Standardized Reform. *Educational Administration Quarterly*, 42(1), 124–156.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *Teachers College Record*, 103(6), 942–1012
- Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report*, 8(4), 597–607.
- Goodwin, C. (1994). Professional vision. *American Anthropologist* 96(3), 606-633.
- Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education*, 35, 258-291.
- Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53(1), 5–26.
- Gresalfi, M. S., & Cobb, P. (2011). Negotiating Identities for Mathematics Teaching in the Context of Professional Development. *Journal for Research in Mathematics Education*, 42(3), 270–304.

- Groth, R. E. (2011). Improving teaching through lesson study debriefing. *Mathematics Teacher*, 104(6), 446–451.
- Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *The Teachers College Record*, 103, 942–1012.
- Hargreaves, A. (1994). *Changing Teachers, Changing Times: Teachers' Work and Culture in the Postmodern Age*. Teachers College Press.
- Hart, L. C., & Carriere, J. (2011). Developing the habits of mind for a successful lesson study community. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 27-38). Springer Netherlands.
- Holland, D., Lachicotte Jr., W., Skinner, D., & Cain, C. (1998). *Identity and Agency in Cultural Worlds*. Harvard University Press.
- Hollebrands, K., Conner, A., & Smith, R. C. (2010). The nature of arguments provided by college geometry students with access to technology while solving problems. *Journal for Research in Mathematics Education*, 41 (4), 324–350.
- Hunter, J., & Back, J. (2011). Facilitating sustainable professional development through lesson study. *Mathematics Teacher Education and Development*, 13(1), 94–114.
- Inglis, M., Mejia-Ramos, J.P., Simpson, A. (2007) Modelling mathematical argumentation: the importance of qualification. *Educational Studies in Mathematics*, 66, 3-21.
- Inglis, M., & Mejia-Ramos, J.P. (2008). How persuaded are you? A typology of responses. *Research in Mathematics Education*, 10(2), 119-133.
- Jaworski, B. (2006). Theory and practice in mathematics teaching development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education*, 9(2), 187–211.
- Jaworski, B. (2012). Mathematics teaching development as a human practice: identifying and drawing the threads. *ZDM*, 44(5), 613–625.
- Kazemi, E. (2008). School development as a means to improve mathematics teaching and learning: Towards multidirectional analyses of learning across contexts. In K. Krainer, & T. Wood (Vol. Eds.). *Participants in mathematics teacher education: Individuals, teams, communities, and networks* (pp. 209-230). In T.

Wood (Series Ed.), *International handbook of mathematics teacher education: Vol.3*. Rotterdam, The Netherlands: Sense Publishers.

- Knapp, A., Bomer, M., & Moore, C. (2011). Lesson Study as a Learning Environment for Coaches of Mathematics Teachers. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 153–164). Springer Netherlands.
- Krainer, K. (2003). Teams, communities & networks. *Journal of Mathematics Teacher Education*, 6(2), 93–105.
- Krummheuer, G. (1995). The ethnography of argumentation. In P. Cobb & H. Bauersfeld (Eds.), *The emergence of mathematical meaning: Interaction in classroom cultures* (pp. 229–269). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.
- Larson, C., Wawro, M., Zandieh, M., Rasmussen, C., Plaxco, D., & Czeranko, K. (2014). Implementing inquiry-oriented instructional materials in undergraduate mathematics. In *Proceedings of the 16TH Annual Conference on Research in Undergraduate Mathematics Education*. Denver, CO.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
- Lewis, C., & Perry, R. (2014). Lesson study with mathematical resources: A sustainable model for locally-led teacher professional learning. *Mathematics Teacher Education and Development (MTED)*, 16(1).
- Lewis, C. C., Perry, R. R., & Hurd, J. (2009). Improving mathematics instruction through lesson study: A theoretical model and North American case. *Journal of Mathematics Teacher Education*, 12(4), 285-304.
- Lewis, C., Perry, R., Hurd, J., & O’Connell, M. P. (2006). Lesson study comes of age in North America. *Phi Delta Kappan*, 88(4), 273-281.
- Maxwell, J.A. (2005). *Qualitative research design: an interactive approach*. Thousand Oaks, CA.
- Meyer, R. D., & Wilkerson, T. L. (2011). Lesson Study: The Impact on Teachers’ Knowledge for Teaching Mathematics. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 15-26). Springer Netherlands.
- Murata, A., Bofferding, L., Pothen, B. E., Taylor, M. W., & Wischnia, S. (2012). Making connections among student learning, content, and teaching: Teacher

- talk paths in elementary mathematics lesson study. *Journal for Research in Mathematics Education*, 43(5), 616–650.
- Murata, A., & Takahashi, A. (2002). Vehicle to connect theory, research, and practice: How teacher thinking changes in district-level lesson study in Japan.
- Stepanek, J., Appel, G., Leong, M., Mangan, M. T., & Mitchell, M. (2007). *Leading Lesson Study: A Practical Guide for Teachers and Facilitators*. SAGE.
- Nardi, E., Biza, I., & Zachariades, T. (2012). “Warrant” revisited: Integrating mathematics teachers’ pedagogical and epistemological considerations into Toulmin’s model for argumentation. *Educational Studies in Mathematics*, 79(2), 157–173.
- Nickerson, S. D., & Moriarty, G. (2005). Professional communities in the context of teachers’ professional lives: A case of mathematics specialists. *Journal of Mathematics Teacher Education*, 8(2), 113–140.
- Olson, J. C., White, P., & Sparrow, L. (2011). Influence of Lesson Study on Teachers’ Mathematics Pedagogy. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 39-57). Springer Netherlands.
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher*, 29(1), 4–15.
- Sherin, M.G., & van Es, E.A. (2009). Effects of video club participation on teachers’ professional vision. *Journal of Teacher Education*, 60(1), 20 – 37.
- Sowder, J. T. (2007). The mathematical education and development of teachers. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning*, (pp. 157-223). Charlotte, NC: Information Age Publishers and National Council of Teachers of Mathematics.
- Spillane, J. P. (2000). Cognition and policy implementation: District policymakers and the reform of mathematics education. *Cognition and Instruction*, 19(2), 141–179.
- Stake, R. E. (1995). *The Art of Case Study Research*. SAGE.
- Stake, R. E. (2006). *Multicase research methods: step by step cross-case analysis*. New York: Guilford Press.
- Staples, M. E. (2008). Promoting student collaboration in a detracked, heterogeneous

- secondary mathematics classroom. *Journal of Mathematics Teacher Education*, 11(5), 349–371.
- Stephan, M. & Rasmussen, C. (2002). Classroom mathematical practices in differential equations. *Journal of Mathematical Behavior*, 21, 459 – 490.
- Stigler, J., & Hiebert. (1999). *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom*. New York, NY: The Free Press.
- Sweeney, G. F. (2012). *Negotiating meaning for the symbolic expressions for vectors and vector equations in a classroom community of practice* (Thesis). University of California, San Diego. Retrieved from <http://scholarworks.calstate.edu/handle/10211.10/3063>
- Takahashi, A. (2014). The role of the knowledgeable other in lesson study: Examining the final comments of experienced lesson study practitioners. *Mathematics Teacher Education and Development (MTED)*, 16(1), 2-17.
- Takahashi, A., Lewis, C., & Perry, R. (2013). A US lesson study network to spread teaching through problem solving. *International Journal for Lesson and Learning Studies*, 2(3), 237–255.
- Tepylo, D. H., & Moss, J. (2011). Examining Change in Teacher Mathematical Knowledge Through Lesson Study. In L. C. Hart, A. S. Alston, & A. Murata (Eds.), *Lesson Study Research and Practice in Mathematics Education* (pp. 59-77). Springer Netherlands.
- Toulmin, S. (1969). *The uses of argument*. Cambridge: Cambridge University Press.
- Tsui, A. B. M., & Law, D. Y. K. (2007). Learning as boundary-crossing in school–university partnership. *Teaching and Teacher Education*, 23(8), 1289–1301.
- Yang, Y., & Ricks, T. E. (2012). How crucial incidents analysis support Chinese lesson study. *International Journal for Lesson and Learning Studies*, 1(1), 41–48.
- Yin, R. K. (2008). *Case Study Research: Design and Methods (Applied Social Research Methods)* (4th edition.). SAGE Publications, Inc.
- Yoshida, M. (1999). *Lesson study: A case study of a Japanese approach to improving instruction through school-based teacher development*. (Unpublished Doctoral Dissertation). University of Chicago, Chicago.
- Yoshida, M. (2012). Mathematics lesson study in the United States. *International*

Journal for Lesson and Learning Studies, 1(2), 140-152.

- van Es, E. Z., & Sherin, M. G. (2010). The influence of video clubs on teachers' thinking and practice. *Journal of Mathematics Teacher Education*, 13, 155-176.
- Vygotsky, L. (1987) *Thought and Language*. Cambridge, MA: The MIT Press.
- Walle, J. V. de, & Lovin, L. A. H. (2005). *Teaching Student-Centered Mathematics: Grades 3-5 Volume 2 (Teaching Student-Centered Mathematics Series)* (1 edition). Boston: Pearson.
- Wawro, M. (2012). Expanding Toulmin's Model: The development of four expanded argumentation schemes from analysis in linear algebra. In (Eds.) S. Brown, S. Larsen, K. Marrongelle, and M. Oehrtman, *Proceedings of the 15th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 242-250), Portland, Oregon.
- Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press.
- Woolcock, M. (1998). Social capital and economic development: Toward a theoretical synthesis and policy framework. *Theory and Society*, 27(2), 151–208.
- Zawojewski, J., Chamberlin, M., Hjalmarson, M., & Lewis, C. (2008). Developing Design Studies in Mathematics Education Professional Development: Studying Teachers' Interpretive Systems. In A. Kelly, R. Lesh, & J. Baek (Eds.), *Handbook of Innovative Design Research in Science, Technology, Engineering, Mathematics (STEM) Education*. Mahwah, NJ: Lawrence Erlbaum Associates.