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Influence of Lesson Study on Teacher Sense of Efficacy in Middle School Mathematics: A Mixed Methods Multiple Case Study Design

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

in

Educational Leadership

by

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2020

The dissertation of Kristin M. Komatsubara is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chair

University of California San Diego

California State University, San Marcos

2020

DEDICATION

To my parents, Kerry and Sharon, who are my first and life-long teachers.

EPIGRAPH

In order to succeed, people need a sense of self-efficacy, to struggle together with resilience to meet the inevitable obstacles and inequities of life.

~Albert Bandura

A deep sense of love and belonging is an irreducible need of all people.
We are biologically, cognitively, physically, and spiritually wired
to love, to be loved, and to belong.

~Brene Brown

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ABSTRACT OF THE DISSERTATION

Influence of Lesson Study on Teacher Sense of Efficacy in Middle School Mathematics: A Mixed Methods Multiple Case Study Design

by

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Doctor of Education in Educational Leadership

University of California San Diego, 2020
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Mathematics education continues to be a critical equity issue in the United States. Traditional teacher-directed math instruction reveals disproportionate numbers of students of color and students of lower socio-economic status struggling to engage and identify as mathematicians (Boaler, 2014). The recent implementation of Common Core State Standards (National Governors Association, 2010) requires significant changes in mathematics instructional pedagogy, content knowledge, assessment, and curriculum. Yet, this shift can result in declining teacher efficacy, leaving teachers feeling overwhelmed and questioning their capacity.

The emergence of lesson study approach holds the potential to impact teacher sense of efficacy as teachers collaboratively build mathematics content knowledge, skills, classroom culture and resources. This mixed methods multiple case study examined whether and to what extent lesson study approach as professional development affected mathematics teachers' sense of efficacy and the social networks of students in their classrooms. It included sense of efficacy surveys from 24 middle school mathematics teachers. Five case study teachers were individually interviewed and social network surveys were collected from the students of their classrooms.

This study supports earlier findings on teacher efficacy but offers new insights into the influence of lesson study approach on teachers' sense of efficacy. Teachers reported four sources of efficacy from lesson study, lesson study shifted the focus from teacher performance to student thinking, and an increased efficacy that they could effectively engage students, utilize student-centered instruction and manage their classroom. Lesson study structures that supported teacher efficacy included sharing a student-centered focus, situating learning with a classroom context, and framing the lesson study. This study also presents a new awareness of help-seeking networks of students in diverse middle school mathematics classrooms. Although teachers did not identify direct links between lesson study and their efficacy to manage student relationships, notable differences in student help-seeking networks emerged. Although there are limitations on generalizability, the findings are especially useful to teachers. Understanding the mechanisms of relationship ties can help teachers attend more intentionally to social participation of students, particularly students of color, English learners, and students with designated disabilities. This study arises at a critical time in

education that may have implications for the types and likelihood of teacher collaboration and school policy.

CHAPTER ONE: INTRODUCTION

Introduction

According to the National Commission on Teaching and America's Future (2007), approximately half of teachers leave the profession within their first five years. Although teaching can be a rewarding career, teachers often express feelings of isolation and frustration with challenging working conditions. A Harvard report (2005) revealed when teachers experience repeated failure, they doubt their capability to teach and consider switching professions. A teacher's sense of efficacy or a teacher's beliefs in his/her ability to effectively instruct students, as well as his/her beliefs about students' capacities, are not only linked to teacher retention but also student achievement and motivation. In order to build a teacher's sense of efficacy, schools must consider ways to provide teachers with support, build a collaborative community and ultimately, empower teachers to succeed.

Statement of the Problem

In the United States, student achievement in mathematics continues to be an equity issue (Bohrnstedt, et al., 2015; Lee, 2002). The math courses a student takes, as early as middle and high school, correlate with economic mobility and success later in life (Rose, 2004). Research suggests that the differences in math tracks can account for up to one quarter of future income gaps between individuals with low income and their more affluent peers (Rose, 2004). As early as elementary school, students perceive mathematics as a fixed characteristic they either possess or do not (Boaler, 2004). Due to the lack of mathematical agency (belief that I can learn and perform), any struggle or setback in mathematics is quickly perceived by students as the inability to do math. This can be exacerbated by harmful instructional practices that perpetuate negative stereotypes and reinforce the belief that math

is not for everyone (Boaler, 2004). Students of color and students from lower socio-economic status are more likely to be in classrooms with traditional instruction focusing on procedural fluency and resulting in mathematical disengagement (Bohrnstedt, et al., 2015; Lee, 2002).

At a time when pressure to increase students' academic performance, particularly in math and science is intense, teacher efficacy is being negatively impacted by dwindling resources and increasing demands of external factors. The importance of teacher sense of efficacy, defined as an "individual (teacher)'s belief in their own ability to plan, organize, and carry out activities that are required to attain given educational goals" (Skaalvik & Skaalvik, 2010, p. 1059) has been highlighted through research that suggests teacher efficacy is linked to positive outcomes in student achievement, student efficacy, teacher instruction in the classroom and teacher motivation (Tschannen-Moran & Hoy, 2007; Tschannen-Moran & Woolfoolk Hoy 2001).

The purpose of this study is to explore whether and to what extent lesson study as professional development affects mathematics teachers' sense of efficacy and the social networks of students in their classrooms. This study arises at a critical time in education that may have implications for the types and likelihood of teacher collaboration and school policy. The recent implementation of Common Core State Standards (National Governors Association, 2010) requires significant changes in mathematics instructional pedagogy, content knowledge, assessment, and curriculum. As teachers experience these drastic changes, they may likely question their efficacy in the classroom and seek resources and reassurance through peer networks. Better understanding the structure and dimensions of teachers and students' social relationships can help to inform how to foster or constrain teacher efficacy and educational change.

Additionally, there are growing concerns over the shortage of STEM (science, technology, engineering, and mathematics) and secondary teachers, who quit the profession at higher rates and report lower efficacy scores than their colleagues (Sutcher et al., 2016). Collaboration and collegiality have been shown to have positive impacts not only on decreasing isolation but providing an avenue for teachers to learn together and ultimately increase their efficacy in impacting student learning (Bruce, et al. 2010; Cowley & Meehan, 2001). Statistics for the retention of teachers paint a somber picture. The National Commission on Teaching and America's Future (NCTAF, 2007) report about half of new teachers leave the teaching profession within their first five years. The National Center of Education (NCES) Profile of Teachers (2011) reported 33% of current public school teachers do not expect to be teaching in K-12 schools five years from now. While 70% of white teachers and 57% of Hispanic teachers expect to be teaching K-12 levels five years from now, less than half (43%) of black teachers expect to be teaching K-12. Unsurprisingly, rates of teacher attrition are highest in hard to fill positions such as mathematics and science. With an increasing number of student age children, secondary schools and schools serving student populations of low-income and minority students (2016) continue to report the highest percentages of emergency credentialed teachers.

Overview of this Study

The model of lesson study or *jugyou kenkyuu*, which originated in Japan was introduced to U.S. classrooms and educators in the 1990s (Fernandez & Yoshida, 2004) and has promising potential for bringing teachers together through long-term collaborative and research learning (Lewis & Hurd, 2011). Research on lesson study as a professional development approach suggests it has the potential to foster teacher collaboration, teacher

content knowledge and teacher sense of efficacy (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Puchner & Taylor, 2006). Yet, lesson study is still fairly new to the United States and its link to teacher efficacy is still being researched in different contexts. Even less common is the study of student networks and relationships in the classrooms of teachers who have participated in lesson study. The following research questions guided my study.

Table 1. Research Questions

1. How and to what extent can lesson studies influence middle school math teachers' self-efficacy around their ability to effectively:
    a. manage students?
    b. engage students?
    c. implement student-centered teaching strategies?
    d. manage peer relations?
2. What do the students' help-seeking networks look like in math classrooms in which lesson study approach is implemented?

Methods

This study took place in four San Diego charter middle schools serving diverse student populations. A total of 24 math teachers and 140 middle school students participated in the study. Data was collected in the form of teacher sense of efficacy surveys, individual teacher interviews, and student social network surveys. Data analysis was organized around two domains that are relevant to teacher efficacy: (1) teachers' mastery and confidence in meeting their students' learning needs and (2) teachers' perceived value of professional development support in the form of lesson study. The networks of student relationships were collected using an established social network survey (Mamas, 2019) and analyzed with UCINET

(Borgatti, Everett, & Freeman, 2002) to conduct descriptive social network analysis by developing network visualizations for each network and calculating network measures, such as density, centrality and reciprocity (Borgatti, et al., 2018; Mamas, 2019).

Significance of the Study

While lesson study approach has been widely used throughout Japan, it is still relatively new but growing in popularity in U.S. schools (Fernandez & Yoshida, 2004). Although lesson study can be used with teachers and classrooms of any grade level and subject, it has been predominantly applied to math classes (Doig & Groves, 2011).

This study explored if and to what extent lesson study influences teacher efficacy around four factors; classroom management, student engagement, instructional practices, and management of peer relations. In addition, I sought to understand what impact, if any, lesson study had on student social networks within classrooms where teachers have participated in lesson study. The following chapter outlines relevant literature and research on the intersection of teacher sense of efficacy, lesson study as a professional development approach, and social networks in the mathematics classroom.

CHAPTER TWO: REVIEW OF RELEVANT LITERATURE

Introduction

In a country where academic success promotes economic mobility, access to good schools and good teachers is paramount. One significant factor that determines teacher capacity is a teacher's sense of efficacy or belief in their capacity to teach and support their students of diverse backgrounds. This chapter reviews relevant literature around teacher sense of efficacy, secondary mathematics education, and the social networks of lesson study through the theoretical lens of social cognitive theory and social network theory.

Conceptualizations of Teacher Sense of Efficacy

Teacher sense of efficacy measures the extent of a teacher's belief in their capacity to guide students to success (Ross, 1992). There are multiple, interchangeable terms which refer to teachers' sense of efficacy including but not limited to self-efficacy, efficacy beliefs, and teacher efficacy (Ross & Bruce, 2007; Tschannen-Moran & Woolfolk Hoy, 2001; Gibson & Dembo, 1984; Ross, 1992). I selected to use the term, *sense of efficacy*, as it is taken from an established teacher efficacy survey that will be applied later in this study (Tschannen-Moran & Woolfolk Hoy, 2001). Sense of efficacy differs from actual or perceived competence because it is predictive of future behaviors to overcome struggles of implementation, even if a teacher is not currently performing or able to perform the desired behavior (Gibson & Dembo, 1984). Teacher sense of efficacy has long captured the interest of educational researchers and practitioners, since both self and collective teacher efficacy predict a series of teacher beliefs, teacher behaviors, and desired student outcomes. Early studies of teacher sense of efficacy were uni-dimensional (Gibson & Dembo, 1984; Midgley et al., 1989) and proved challenging to accurately capture teacher efficacy. But overtime researchers have come to conceptualize

teacher sense of efficacy as multifaceted with various influences and outcomes (Tschannen-Moran & Hoy, 2001).

Teachers' sense of efficacy beliefs and student academic achievement

Increased levels of student achievement have been linked to teachers with a high sense of efficacy (Caprara et al, 2006; Goddard, Hoy & Woolfolk Hoy, 2004; Tschannen-Moran & Wolfolk Hoy, 2001; Ross, 1998; Ross, 1992). One of the most significant characteristics of teachers with a high sense of efficacy is their belief that with effort, they are able to support and teach the most challenging students (Ross, 1995; Smylie, 1990). And although teacher sense of efficacy is an internal perception, not an outward effective measure, teachers with reportedly higher senses of efficacy generate stronger student achievement results than teachers with lower senses of efficacy (Goddard, Hoy & Woolfolk Hoy, 2004; Ross, 1998). The effects of teacher sense of efficacy on student achievement can be linked to several teacher beliefs and behaviors.

First, teachers with low sense of efficacy are less likely to persist in supporting struggling learners (Ross, 1995; Ashton, Web & Doda, 1993; Smylie, 1990). Teachers with low-efficacy generally concentrate their efforts around teaching high-achieving students and perceive struggling students as more likely to be disruptive to classroom learning (Ashton, Web & Doda, 1993). In contrast, teachers with a high sense of efficacy report positive attitudes of working with struggling learners, they make efforts to build strong relationships with them, and convey higher expectations for this group of students than their teaching peers with a lower sense of efficacy. Sense of efficacy also influences teachers' beliefs around student learning and teacher effort. Teachers with a high sense of efficacy view student

mistakes and struggle as an opportunity to increase their effort instead of dismissing student failure as beyond their control.

Second, multiple studies have predated and confirmed that teacher sense of efficacy predicts both the effective implementation of new practices and new curriculum, as well as a teachers' willingness to seek out coaching and external supports for improving their pedagogy (Ross, 1998; Ross, 1995; Ross, 1992; Smylie, 1990). Multiple studies have predated this and confirm the link between teacher sense of efficacy and the implementation of new teaching practices and reform such as Smylie's (1988) development of three items to measure personal teacher efficacy. Anderson, Green, and Loewen (1988) used Gibson & Dembo's established teacher efficacy scale and found that personal teacher efficacy predicated student achievement in mathematics, reading and language in elementary but not in middle school. Finally, Stein and Wang (1988) asked teachers to rate how well they could implement a new interactive teaching program to find that personal teaching efficacy resulted in higher levels of implementation.

Third, teachers with a high sense of efficacy use classroom management strategies that encourage student autonomy. Teachers with reported high sense of efficacy beliefs are more likely to feel confident in giving students more agency within the classroom. Autonomous classroom management strategies such as students co-creating norms, selecting their level of work challenge, and deciding when to call a teacher during group work, keep students cognitively engaged more effectively than traditional authoritative management strategies (Woolfolk, Rosoff & Hoy, 1990).

Differences in Teacher Sense of Efficacy

As students transition from elementary to middle school, they experience changes within the classroom contexts. Teachers are a key feature of classroom contexts. These differences in classroom contexts may contribute to the downward trend observed in student academic performance, engagement and motivation. This trend has been shown to have long-term consequences for students' academic and career paths (Eccles, Vida, & Barber, 2004). Correlated to their downward trend, research finds overall teachers' self-efficacy also declines from elementary to middle school (Midgley et al., 1988, 1989). While teacher sense of efficacy generally declines at the middle school grades, research notes there are more drastically low levels of efficacy related to managing peer relations and classroom management (Ryan et al, 2015). These differences can be attributed to large class sizes in middle school and students having multiple teachers with different subjects, as opposed to a smaller, self-contained classroom in elementary school. Additionally, the importance of peer relationships could become a priority in middle school over academic pursuits. These challenges may make it harder for middle school teachers to find ways to effectively engage students and build meaningful relationships with them.

Measuring Teacher Efficacy

Researchers have argued about the characteristics and methods of measuring teacher sense of efficacy. A frequent instrument to measure teacher efficacy (Gibson & Dembo, 1984) produces two scores; a general teacher efficacy score and a personal teacher efficacy score. The general teacher efficacy score explores the belief of a teachers' ability to impact change is controlled by external school and community factors. The personal teacher efficacy score examines a teacher's belief to directly impact student learning within their classroom. Another

early study used Bandura's (1997) definition of efficacy to measure personal teacher efficacy as a single construct (Schwarzer, Schmitz, & Daytner, 1999). Researchers developed a short 10-question instruction asking teachers to rate their confidence in enacting tasks with elements of challenge.

Bandura presented his own 30-item scale measurement with seven dimensions of teacher self-efficacy including 1) influencing decision making, 2) influencing school resources, 3) instruction, 4) discipline, 5) enlisting parental involvement, 6) enlisting community involvement, and 7) creating a positive school. While Bandura's scale is multidimensional, it is not frequently used to measure teacher self-efficacy in the United States. Lack of application may occur because characteristics and daily struggles defining teachers' roles are not present in the questions posed.

Sense of efficacy is a multidimensional construct (Skaalvik & Bong, 2003). Thus, a more multi-dimensional scale has emerged to measure teacher self-efficacy within three domains: classroom management, instructional strategies, and student engagement.

Sources of Teacher Sense of Efficacy

Bandura (1986, 1997) proposed four sources of information that influence both individual and collective teacher efficacy: mastery experience, vicarious experience, social persuasion, and affective states.

Mastery experience

Throughout their careers, teachers will collectively experience both successes and failures. Successes help to reinforce and bolster an individual and shared belief in a faculty's controlled impact on student learning. In contrast, failure can produce doubt and discouragement among teachers. Mastery experience is defined as the direct teaching

experiences that are challenging but highly successful. A resilient sense of teacher efficacy is required to help move individuals beyond inevitable challenges. Of the four factors identified by Bandura to increase teacher efficacy, mastery experience is believed to be the most significant because these experiences resulted in higher teacher confidence from their observations of the impact of instruction and student performance.

Vicarious experience.

Although the act of teaching is often done in isolation, teachers regularly interact outside their classrooms. Through these interactions, teachers learn about other colleagues' achievements. Similarly, schools learn by studying other schools (Huber, 1996). Vicarious experiences can also be powerful influencers of increased teacher efficacy. When teachers observe similar teachers of perceived ability, within similar contexts, experience instructional success, they are more likely to believe that these experiences are replicable within their own classrooms (Bruce et al, 2010).

Social Persuasion

Professional development, instructional coaching, and social media can also influence teacher efficacy. However, exposure to successful models is not enough to aid in change. It should be coupled with positive direct experiences to fully allow persuasion to motivate a faculty or individual into action. Social persuasion alone does not have lasting results on teacher efficacy. Instead, it serves as a quick boost but can be easily dismantled by disappointing or unsuccessful results. Regular exposure to negative experiences can lead individuals to avoid challenges and quickly quit at the first sign of difficulty. Therefore, efficacy builders must do more than praise but place teachers in meaningful situations where they will experience an appropriate level of challenge with support and earned success.

Affective States

An individual's emotional state of being can directly impact their perception of future success. Feelings of stress, depression, and tension can negatively affect individuals as well as organizations. By reducing an individual's negative emotional state and helping them reframe their perspective and interpretation of feelings, teachers are more likely to increase their efficacy.

Teacher Behaviors & Beliefs that Impact Student Achievement

A significant collection of research has linked teacher efficacy as a reliable precursor to teacher beliefs and behaviors that ultimately impact student achievement (Caprara et al, 2006; Goddard, Hoy & Woolfolk Hoy, 2004; Tschannen-Moran & Wolfolk Hoy, 2001; Ross, 1998; Ross, 1992), see Figure 1 below. Teacher beliefs and behaviors linking efficacy and student achievement include but are not limited to; instructional strategies, student engagement, classroom management, and managing peer relations. Below I outline the details of these teacher beliefs and behaviors in the classroom.

Instructional Strategies

Current school reform led by the adoption and implementation of Common Core standards has required mathematics teachers to drastically alter the mathematical content, pedagogy, and instructional practices they use to teach. Mathematics teachers respond to reform in a multitude of ways; embracing, struggling with, questioning, ignoring, reverting to more comfortable methods, accepting and sometimes openly denouncing the reform efforts. Yet evidence from brain research shows that by focusing on understanding and applying concepts deeply the brain is able to retain more information and compress ideas, in comparison to memorizing segmented procedures and facts (Gray & Tall, 2007). This

research suggests that when math is taught in a student-centered approach with emphasis on student ideas, discourse, and meaning-making, students are more likely to learn and value math (Boaler, 2014). PISA (Program for International Assessment) tests scores from over thirteen million students worldwide from the reveal similar findings--students who relied upon memorization strategies scored the lowest (OECD, 2014). Teachers with high self-efficacy are more likely to adopt and persist with challenging yet effective strategies (Ross, 1998; Smith, 1996).

Student Engagement

Teachers with higher efficacy motivate students to do well and value learning (Ryan et al., 2015; Bruce et al., 2010). Through extended time working with struggling learners, teachers with high efficacy consciously and subconsciously communicate their belief in students. This transforms a students' self-perception and mindset about their own academic abilities (Ashton, Webb & Doda, 1983). In contrast, teachers with lower efficacy spent more time working with higher achieving learners and less time working with struggling learners since they perceived them as disruptive to the others' learning.

Classroom Management

A well-managed classroom is essential to creating a safe and welcoming learning environment that promotes student achievement. Student management beliefs vary but can be viewed as a continuum which ranges from custodial to humanistic (Willower, Eidell, & Hoy, 1967). Custodial perspectives utilize a regimented hierarchy with power and communication moving from teachers to students. Students in custodial managed environments are controlled, compliant, and passive learners while misbehavior is punished and corrected. On the opposite end of the spectrum, humanistic perspectives view management as the co-construction of a

democratic learning community. In place of teacher control, students' self-discipline is desired. Teachers work to understand the foundations of student behavior in order to motivate learning. Communication between teacher and students allows for greater student agency and autonomy.

Teachers with high efficacy display confidence in effectively managing their classroom as they implement humanistic approaches to student regulation and encourage students to take responsibility for their learning (Eshel & Kohavi, 2003; Pintrich & De Groot, 1990). These teachers utilize management strategies that allow students to be better at self-regulation, develop strong study habits and persist in problem solving (Pintrich & De Groot, 1990).

Managing Peer Relations

A teacher's sense of efficacy for peer relations measures their confidence in creating a learning environment where students develop positive relationships with their peers and where the teacher can effectively help students navigate social problems and friendships. This is particularly important at the transition to middle school when students place a higher priority on social networks. Although a teacher may have limited and indirect influence on friendships in the classroom, a teacher can still directly attend to a students' academic status and create classroom cultures where students experience a sense of belonging (MAIC, 2018). By using student-centered practices and focusing class discussions on sense-making instead of traditional speed and procedural fluency, students will begin to recognize all students have mathematical ideas and value to contribute to the learning (Boaler, 2006, Gutierrez, 2000; Boaler, 1997). Leveraging a students' academic status and reinforcing student working relationships has the potential to spill over into a student's social networks outside of the

classroom.

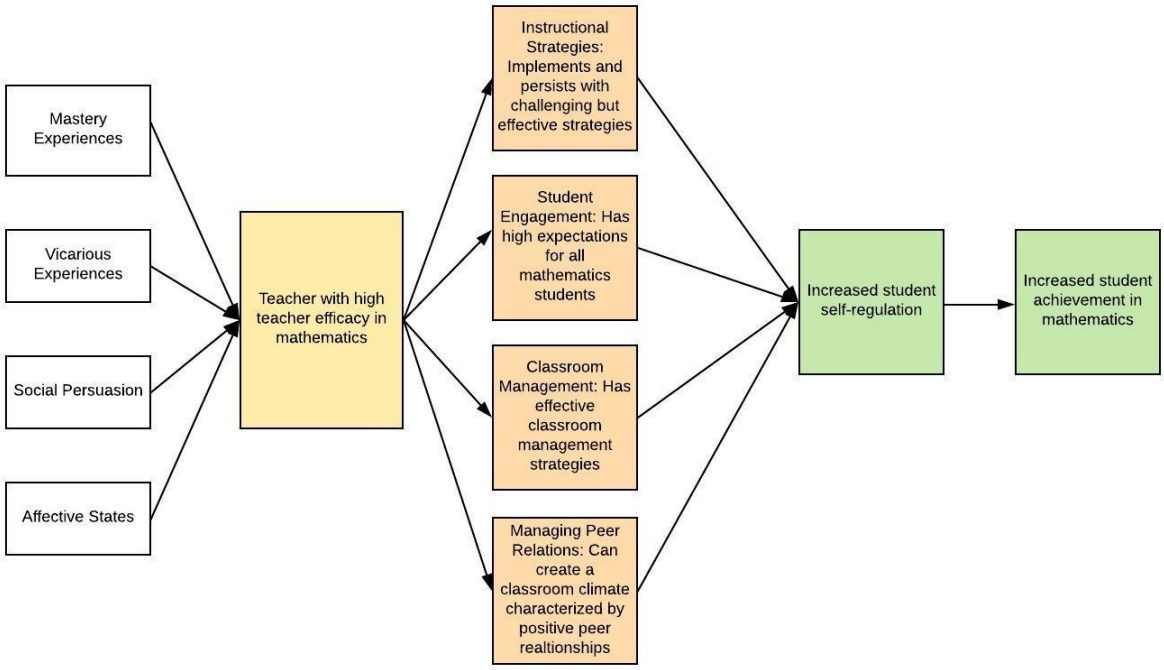

Figure 1. The relationship between teacher efficacy and student achievement (Bruce et al., 2010; Ryan et al., 2015)

Elements of Teacher Efficacy

Although Bandura's four sources of information provide a foundation of factors influencing teacher efficacy, this information must be cognitively processed and individually interpreted by teachers to form their sense of efficacy. In addition, sense of efficacy is a self-perception and not a direct measure of effectiveness. The following diagram highlights the factors influencing teacher sense of efficacy and their relation to student achievement in mathematics.

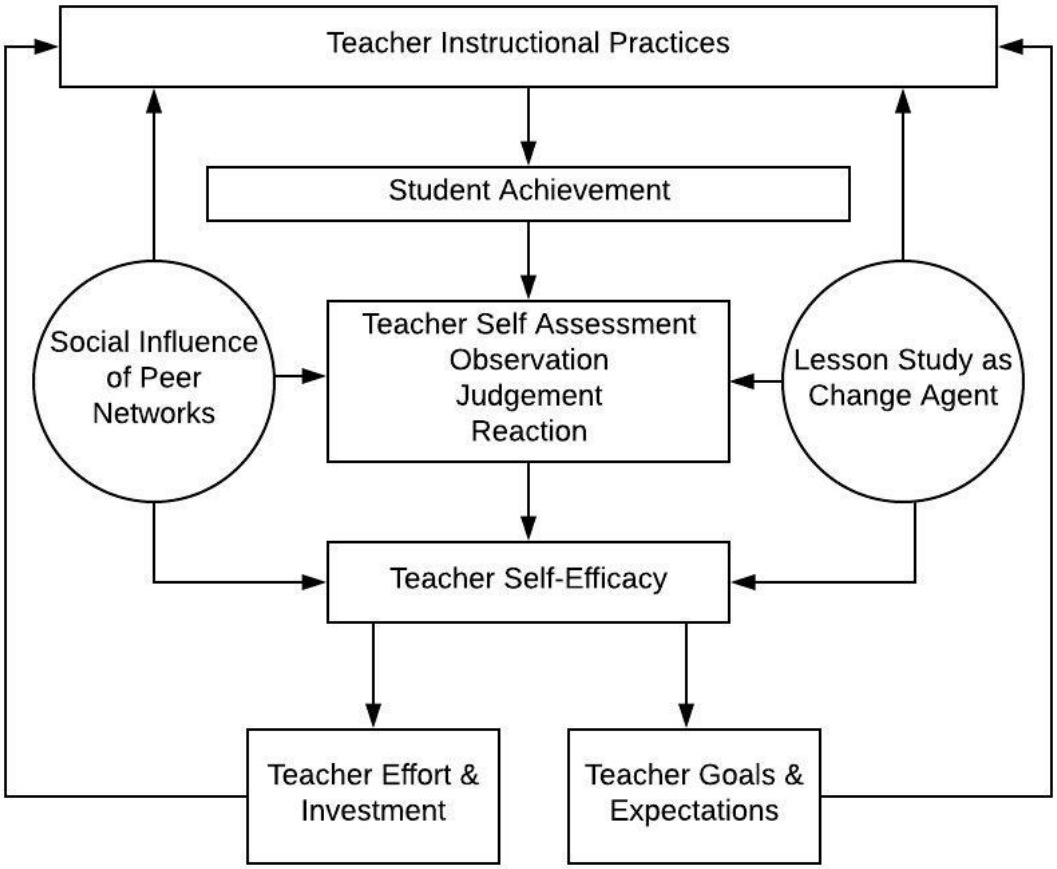

Figure 2. Model of teacher self-assessment as a mechanism for teacher change (Ross & Bruce, 2007)

Teacher Collaboration & Student Social Networks

Recently, researchers and school leaders have invested more time and resources in professional development that taps into the power of teachers' social and professional networks. Professional development opportunities might include forming professional learning communities (PLCs), creating time and space for teacher meetings, and hiring coaches to provide feedback to teaching teams. With the understanding that teachers learn best through social interactions, educational leaders are actively seeking opportunities for teachers to learn with and from one another. In tandem, policy makers are creating legislation

that impacts and re-organizes the ways teachers work together. Past research suggests teachers with access to strong professional communities, such as those developed through lesson study, are more likely to change their instructional practices and increase student achievement, than their peers without access to these relationships (Lewis & Perry, 2017; Lewis et al, 2009). While extensive studies have been conducted on teacher collaboration through lesson study, much less is known about the impact lesson study has on the social networks of students.

Theoretical Framework

Social Cognitive Theory

Social Cognitive Theory (Bandura, 1986) advanced from Bandura's original work on social learning theory from the 1960s. Bandura proposed that an individual acquires knowledge from observation of others within the context of social interactions, media influence, and personal experiences. Social cognitive theory suggests that individuals do not just randomly attempt behaviors to either succeed or fail. When people observe another individual performing a behavior and its subsequent consequence, they recall the sequence of these events as a guide for their own aligned behaviors. This pattern allows humans as a society to replicate the actions of others. The reward or punishment for the behavior determines whether observing humans will repeat or abandon the behavior. Teacher sense of efficacy is a construct that was developed within the context of Bandura's social cognitive theory.

Social Capital Theory

Social networks provide access to resources, expertise, knowledge and social support. To understand social networks, social capital theory must be applied (Daly, 2010; Putnam,

2000). Social capital theory provides a lens for studying the role social interactions play in exchanging and influencing information, behaviors and thinking between individuals within a group. Social networks are often described through their density and centralization. Density of a network refers to the number of existing ties in comparison to the number of possible ties between individuals. A dense network will have a higher proportion of ties in comparison to a sparse network (Daly et al, 2010; Moolenaar et al, 2010).

A key characteristic of social capital theory is that through social relationships, individuals borrow, exchange, and leverage resources in order to achieve their goals (Moolenar et al, 2012). In this sense, one key provision of social relationships is the social support transferred and received between individuals. Dumont and Provost (1999) describe social capital as a multidimensional concept, which can be observed as four types of behaviors (House, 1981). The four behavior outlined include (a) emotional support through the expression of love, care, and trust, (b) instrumental support through the provision of information, knowledge, and advice given to assist an individual's need, (c) informational support through the provision of information, knowledge, and advice given to address an individual's problem, and (d) appraisal support through constructive critique, feedback and affirmations.

The lens of Social Cognitive Theory and Social Capital Theory can be applied to study teacher sense of efficacy and student social networks. Through lesson study, teachers exchange knowledge, provide valuable feedback, and share emotional support. By observing one another and sharing in learning, teachers collaboratively grow their capacity and sense of efficacy. Additionally, the classroom culture teachers create by participating in lesson study can be studied through social capital theory and analysis of student networks.

Lesson Study

Lesson study, also called *jugyou kenkyuu,* is an educational professional development practice from Japan, which emerged in the United States during the 1990's (Fernandez & Yoshida, 2004). While lesson study is utilized across all grade levels and content areas, it is most commonly used in mathematics teaching (Doig & Groves, 2011). Groups of teachers engage in lesson study to collectively plan, teach, and reflect on the learning. There are three main variations of lessons study groupings; lesson studies can be hosted by teachers within a single school site, across a school district, or through a public demonstration with an invitation to affiliated educators, family members, and community members. Lesson studies generally consists of the following components: 1) studying the curriculum and selecting a focus, 2) planning the lesson, 3) public teaching of the lesson with focused observation of the lesson based on group's objectives, and 4) evidence-based debrief with revision based on group reflection (see Figure 3). An important part of the lesson called *kyozai kenkyuu* refers to the in-depth study of materials. Materials may include textbooks but often extend to understanding the content or skills being taught, exploration of curriculum resources, and seeking out research or experts in the field.

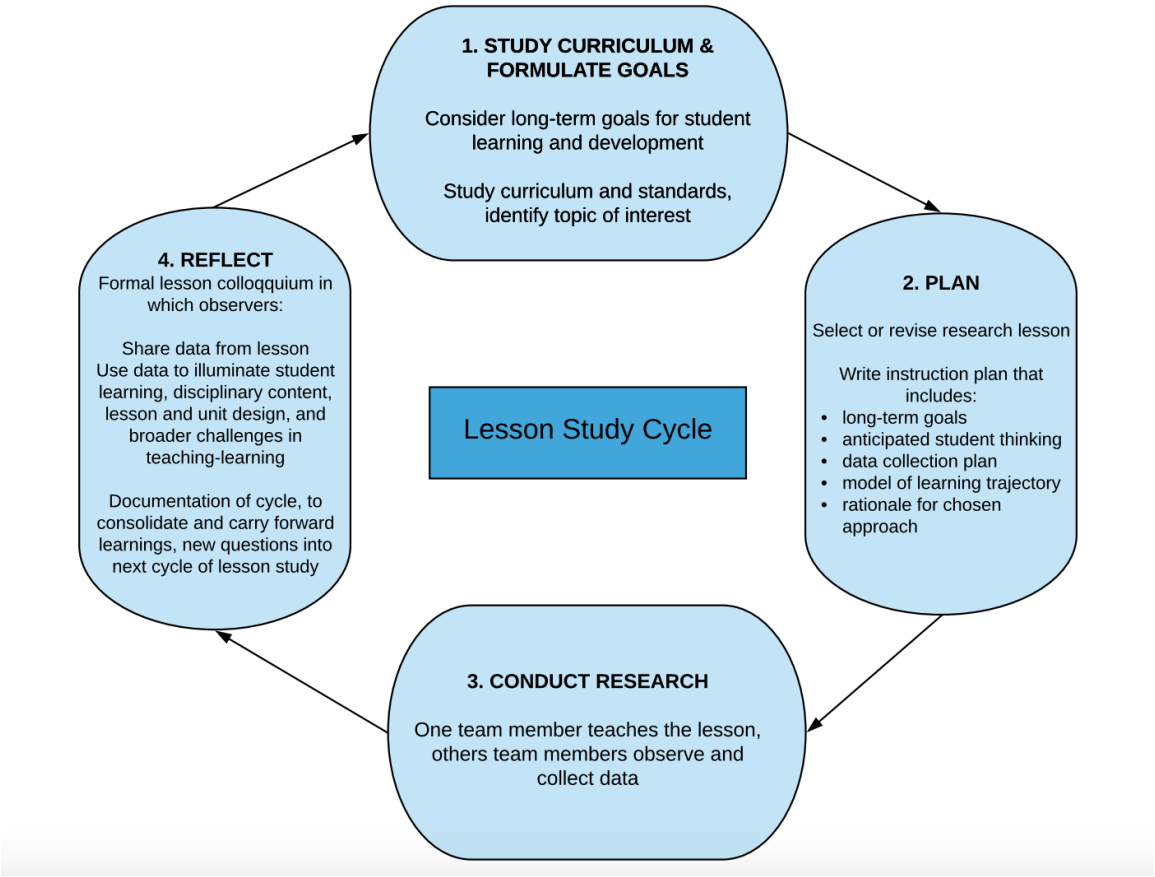

Figure 3. Lesson Study Cycle (Lewis, 2011)

Lesson study holds promise because it has the potential for engaging teachers in sustained and inquiry-based professional development. Unlike most professional development initiatives, lesson study is generally unfunded or mandatory (Doig & Groves, 2011). This ensures teachers self-select to participate in the lesson study and collectively choose a question of genuine interest to drive the process. Table 2 outlines the unique characteristics of lesson study in comparison to traditional methods of professional development.

Table 2. Elements of Traditional Professional Development vs. Lesson Study Approach

Traditional	Lesson Study
Begins with answer	Begins with question
Driven by outside "expert"	Driven by participants
Communication flow: trainer → teachers	Communication flow: among teachers
Hierarchical relations between trainer and learners	Reciprocal relations among learners
Research informs practice	Practice is research

(Liptak, 2005)

Why lesson study?

At a time when many schools and teachers are struggling with reform overloads, why is lesson study important? There is a growing body of evidence that lesson study and closely related practices improve student learning (Lewis et al., 2006 Lewis, Perry & Hurd, 2009; Foster and Poppers, 2009; Waterman, 2011). These studies suggest that lesson study's effectiveness is linked to teachers' increase of content knowledge and pedagogy and a focus on student thinking.

Collaboration & Autonomy

A recent report finds that teachers spend about 3% of their teaching day collaborating with colleagues, leaving most teachers planning, teaching and reflecting on their practice alone (Mayer & Phillips, 2012). Yet, many the majority of teachers yearn to collaborate and express value in collaboration (Mayer & Phillips, 2012). The process of lesson study demands teachers collaborate. When studying the literature of teacher collaboration, Little (1990) identified a range of different types of teacher collegiality. Some types of teacher collaboration built teacher productivity while others enhanced competition and the feeling of

isolation. At the two ends of the spectrum, Little documented types of "joint work" that required shared responsibility and types of "opportunistic" interactions where teachers shared stories that cemented their beliefs and practices (1990). Joint work encouraged teachers to rely on one another in their collaborative planning and teaching. In contrast, opportunistic engagement reaffirmed teachers' beliefs both positive and negative about student learning and instruction (Little, 1990). Lesson study is a form a joint work and has the potential to collectively impact teachers' sense of efficacy.

In addition, the collaborative nature of lesson study builds a professional learning community of teachers that exchange knowledge and build a value for instructional improvement. Stigler and Hiebert's (1999) *The Teaching Gap* argues that lesson study approach supplies development of shared knowledge base around teaching and learning, a key component missing in current reform.

Career Advancement Instead of Career Change

Lesson study also provides teachers pathways to develop as professionals without leaving the classroom. This is significant to retain high quality teachers, instead of having them move into traditional positions of leadership. With the increase in the number of US school districts hosting public lesson studies and publishing lesson study findings, teachers' voices and contributions to the profession are recognized while still remaining in the classroom.

Teacher Sense of Efficacy & Motivation Related to Lesson Study

Most importantly lesson study has the potential to change a teacher's beliefs of their own ability to help students learn (Lewis & Hurd, 2011; Bruce et al, 2010). Although sense of efficacy may fluctuate through a teachers' career as they experience setbacks, success, and

failure, research on lesson study reveals teacher sense of efficacy and professional actions are reciprocal (Bruce et al, 2010; Puchner & Taylor, 2006).

Research Questions

In the next chapter, I address the methodology proposed to answer the following research questions:

1. How and to what extent can lesson studies as professional development influence middle school mathematics teachers' self-efficacy beliefs around their ability to effectively:
    a. manage students?
    b. engage students?
    c. implement student-centered teaching strategies?
    d. manage peer relations?
2. What do the students' help-seeking networks look like in classrooms in which lesson study approach is implemented?

CHAPTER THREE: METHODOLOGY

Introduction

This chapter provides a methodological account and rationale for my study that utilized a mixed methods multiple case study convergent design. I sought to understand if and to what extent lesson study as professional development influences mathematics teachers' sense of efficacy around four factors: classroom management, student engagement, student-centered instructional practices, and peer relationships. In addition, I aimed to examine the student social networks in classrooms where teachers participated in lesson study. In addressing the two research questions, I strived to make methodological choices that would formulate a coherent design influenced by ethical considerations for participants and classroom practices.

Crotty's (1998) framework provided a 4-tiered framework for conceptualizing the research process. At the top tier, philosophical assumptions, also referred to as paradigm or worldview, represent the set of assumptions and beliefs held by researchers about knowledge informing their study (Creswell & Clark, 2018). Narrowing the perspective, a researcher uses a theoretical or conceptual framework as a lens to explain what they expect to find in their study (Crotty, 1998). The last two tiers outline a researcher's methodological approach and methods of data collection and analysis. The following figure outlines the four levels of research within my multiple case study design.

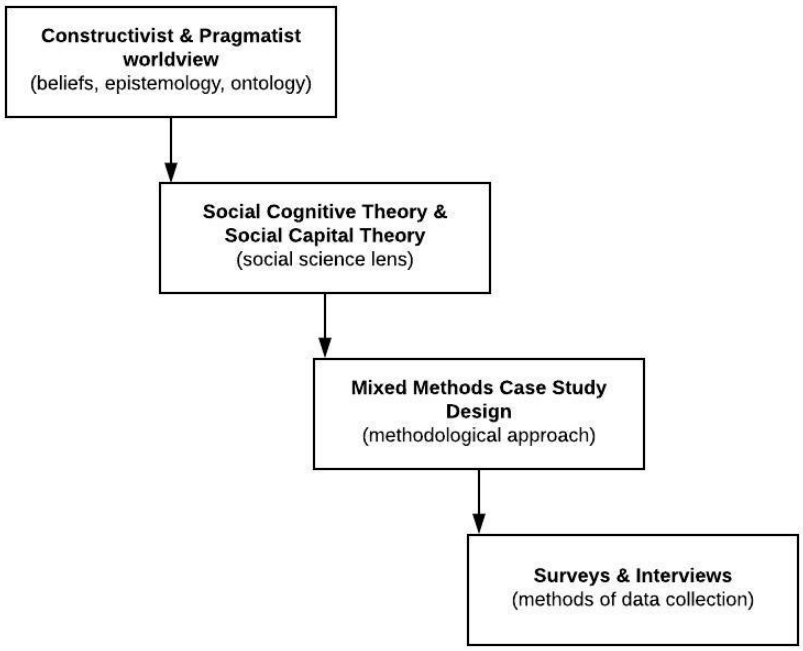

Figure 4. Four Levels of Research Study

Paradigm Worldview

Throughout this study, I employed elements of constructivist and pragmatist worldviews, also referred to as *paradigms* (Kuhn, 1970), to guide my inquiry. Each worldview consisted of unique beliefs and assumptions that influenced how knowledge is understood. The following paragraphs outline how the specific elements of constructivist and pragmatist worldviews were applied to this research study.

Constructivists apply an inductive methodology using multiple participant perspectives that build to patterns and theories around larger themes and concepts (Denzin, 2012). In this research, themes from interviews of teacher experiences with lesson study and its possible impact on self-efficacy were constructed from teacher quotes that illustrate their different views. The relationship between myself as the researcher and the teachers being researched was one of closeness and subjectivity. Teachers were interviewed and data was

collected at their school sites. This was coupled with the fact that as a regular participant and advocate for lesson study, I actively expressed and held personal biases and perspectives. The epistemology or relationship between myself, participants and the study, in addition to the axiology or role of my values, were both characteristics of constructivism.

While my research included characteristics of constructivist worldviews, there were also characteristics of pragmatism. Pragmatists collect and mix qualitative and quantitative data from studies to address their research questions (Tashakkori & Teddlie, 2010). Aligning with this worldview, I collected qualitative data from teacher interviews and quantitative data from student and teacher surveys. In line with pragmatist worldviews, findings were conveyed with both formal and informal language. The following table outlines elements of each paradigm worldview.

Table 3. Elements of Worldviews and Implications for Practice

Philosophical Questions	**Paradigm Worldview**
Ontology (the nature of reality)	Constructivists utilize multiple realities by collecting quotes to illustrate unique perspectives of participants.
Epistemology (relationship between researcher and the research participants)	Constructivists visit with participants at their site and share a closeness in proximity and subjectivity. Additionally, pragmatists collect convenience data and what "works" to address their research question(s).
Axiology (role of values)	Constructivists predominantly include a biased perspective as they talk about their personal experiences and interpretations.
Methodology (process of research)	Pragmatists combine both quantitative and qualitative data. Constructivists also use an inductive approach that begins with participants' views and builds upward to generalizing patterns and interpretations.
Rhetoric (language of research)	Pragmatists use both formal and informal language to convey data findings.

Source: Adapted from Creswell (2013).

Theoretical Lens

Bandura's social cognitive theory (1986) provided a framework for analyzing teachers' sense of efficacy. Social cognitive theory suggests that individuals acquire knowledge from observation of others within the context of social interactions, media influence, and personal experiences. When people observe another individual performing a behavior and its subsequent consequence, they recall the sequence of these events as a guide for their own aligned behaviors. In using social cognitive theory as a lens, teacher interview data and teacher efficacy survey scores were analyzed to determine the factors, experiences, and complexities that may shape a teacher's sense of efficacy. As teachers described their experiences and beliefs from lesson study, particular attention was given to their references of learning from observation, peer influence, and social interactions.

Methodological Approach

A mixed methods multiple case study design with convergent approach was selected as the methodological approach. This approach sometimes referred to as *parallel study* (Tashakkori & Teddlie, 1998) was chosen because quantitative data and qualitative data would be simultaneously collected to compare and combine the results (Creswell & Clark, 2018). According to Tashakkori and Teddlie (2003), mixed methods case studies have particular value when analyzing complex educational phenomena and problems. Capturing the efficacy beliefs of teachers and its potential relationship to student social networks is a unique topic that made this study a strong candidate for a mixed methods investigation. Quantitative data was collected through a teacher sense of efficacy survey (Tschannen-Moran & Woolfolk Hoy, 2001) and a student social network survey (Mamas, 2019). Qualitative data were collected through individual semi-structured teacher interviews about their experiences

with lesson study and sense of efficacy. These converging sets of data helped to understand complex organizations, such as schools, and allow a comparison between each case. With minimal impact-time on the classroom, teacher and student data were collected simultaneously to describe and analyze similarities and differences between teacher and classroom cases.

There are several strengths associated with the mixed methods case study convergent design which include a more robust understanding of the problem, validating one set of data in comparison to another, and determining if participants respond in similar ways when completing a predetermined survey and when answering open-ended questions during an interview (Clark & Ivankova, 2016; Creswell & Clark, 2018). In complex systems such as schools and classrooms, a mixed methods case study design allows researchers to collect qualitative and quantitative data to develop practical, yet in-depth understanding of various cases (Creswell & Clark, 2018). Descriptive profiles of each teacher and classroom case, helped provide a more complex and detailed understanding of the problem or situation. As multiple cases were studied, research could compare the unique characteristics of each case and highlight how the cases provide insight about the overarching problem or question.

There are also challenges and limitations associated with the mixed methods multiple case study convergent design that should be considered. When applying a mixed methods case study design, researchers must decide on the number and identification of cases. As researchers consider a single or multiple case study and which cases to select, they may question how cases might best portray the diversity of cases available (Creswell & Plano Clark, 2018). Inevitably, not all cases can be studied and through their selection, researchers must acknowledge what is included, emphasized, and missed from a larger population of

cases. While some information may be transferred, mixed methods case study designs are unique to the cases studied (Yin, 2017). Figure 5 outlines the qualitative and quantitative data that have been collected and analyzed in this convergent case study design.

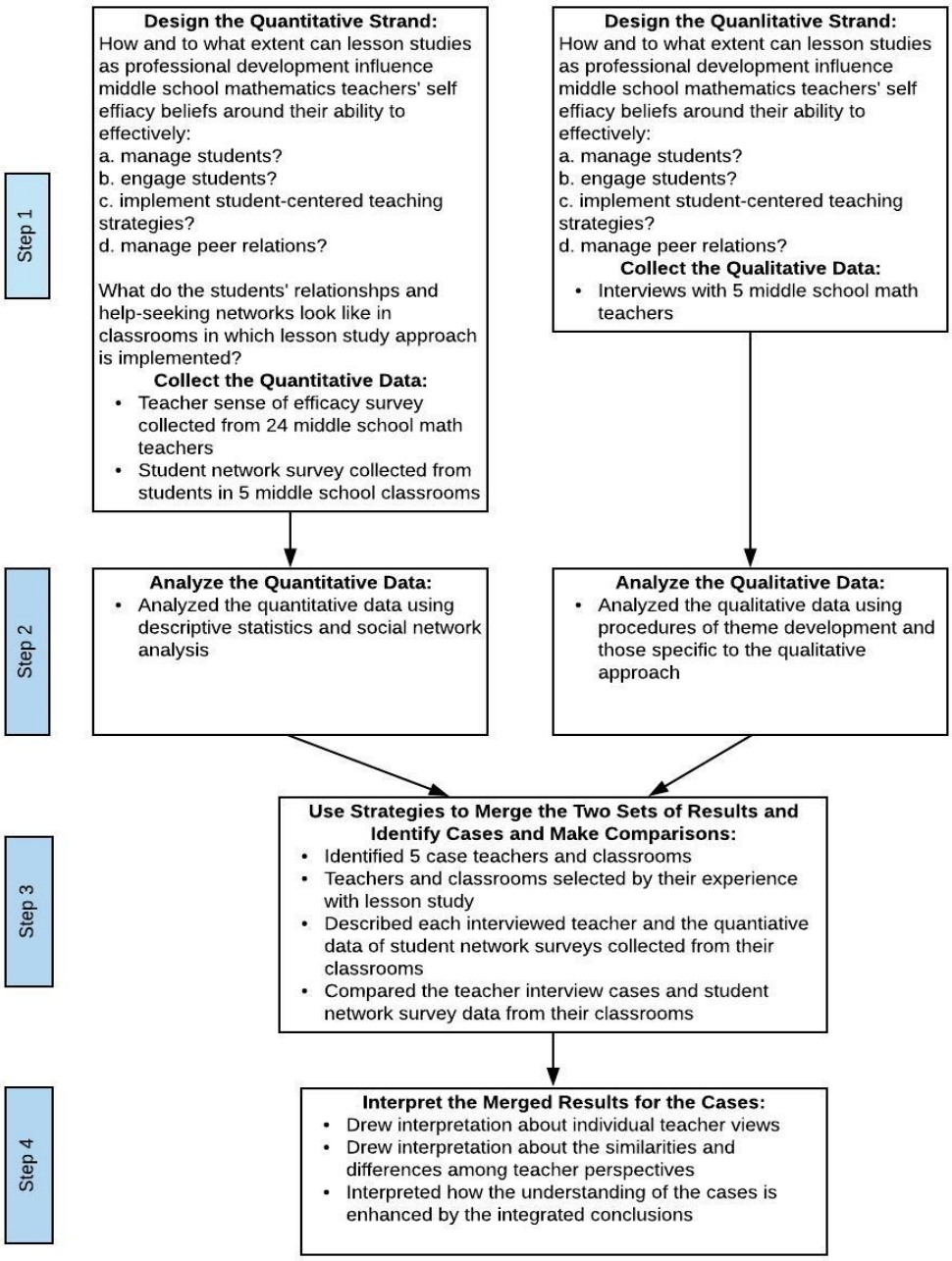

Figure 5. Flowchart of Implementation of Mixed Methods Case Study Design with a Convergent Approach

Context of the Study

This study was conducted within a project-based learning organization that currently consists of a graduate school of education and a network of 14 charter schools that serve a range of K-12 student populations. In this study, I refer to the organization by the pseudonym, Helix Network. In 2000, the Helix Network organization was established as an equity project with roots in the civil rights movement. As part of their equity mission, Helix Network values integrated classrooms and aim to serve a range of students with varying economic backgrounds, life experiences, ethnicities, languages, and learning profiles. As such, the school charter uses a zip code lottery system to ensure that a diverse student population, reflective of the greater San Diego County, is selected. In the 2018-19 school year, Helix Network served 5162 students of which 28% are Caucasian, 53% Hispanic, 7% African-American, 10% Asian, 2% Native American, and less than 1% Pacific Islander; 50% qualify for free or reduced lunch, 14% are on special education plans, and 11% are classified as English learners (California Department of Education, 2019).

Since 2016, the Center for Research on Equity and Innovation at the Helix Network Graduate School of Education formed the Mathematical Agency Improvement Community (MAIC). MAIC is composed of a coalition of 17 Southern California schools including four Helix Network middle schools which aim to improve student agency and learning outcomes in math, particularly for students from traditionally marginalized groups (MAIC, 2016). MAIC strives to develop and spread mathematical practices that foster the following student characteristics:

- Growth Mindset - “I can learn if I put in the effort”
- Sense of Belonging - “I am part of a mathematical community”

- Purpose/Value - “I feel intellectually engaged and challenged.”

Through professional development structures such as lesson study (see Appendix C), MAIC aims to improve teacher instructional practices that promote equitable student interactions.

A growing body of research indicates that students learn complex mathematical skills and ideas best when given opportunities to engage in academic discourse with their peers and teachers (Smith & Stein, 2016). This requires a shift in mathematical authority as teachers learn to become facilitators of student-centered discussions in place of traditional teacher-centered instruction. Additionally, teachers must strive to help students in seeing themselves as mathematically competent in order to strengthen their academic identity and their sense of belonging to the mathematical community. In classrooms, students build their academic identity based on their interpretation of the interactions and feedback received from their peers, teachers, and the larger school community.

Participants

Participants included 24 middle school mathematics teachers from four middle charter schools in the Helix Network organization. The four schools belong to the same charter organization but are located in three different cities. These four schools were selected because they belong to the Helix Network organization and Mathematical Agency Improvement Community which have the mission of serving a diverse student population and creating equitable learning experiences. In particular, mathematics teachers at each of these schools have participated in professional development such as lesson study with the intent of developing more student-centered and discourse-based instructional practices. Building these

collaborative math classrooms is challenging. Yet this makes the four middle schools an ideal setting in which to study teachers' sense of efficacy and student social networks.

Within each school site, mathematics teachers have a range of experiences with lesson study and the number of years they have taught mathematics. Five math teachers and their classrooms were selected as focus cases. These five teachers were identified based on their experience with lesson study (number of cycles participated in), the number of years they have taught mathematics, and their school campus. A scattering of experiences, in addition to different teacher genders and racial backgrounds, were intentionally selected to provide a diverse voice of the experiences with lesson study. Some teachers have experienced only a few rounds of lesson study and are in the first few years of their teacher careers while other teachers have over 10 years of experience and have experienced multiple rounds of lesson study. It is noted that the number of years of teaching experience do not always correspond to the number of lesson study cycles participated in. The following figure outlines the 24 participating teachers from the four middle schools and the selected 5 focus case-study teachers.

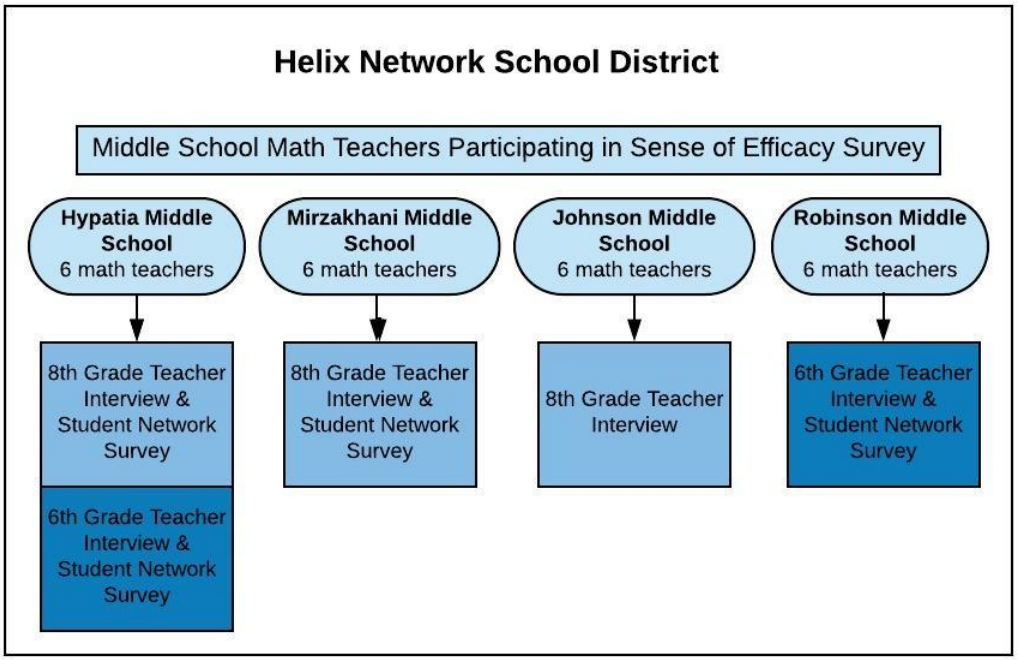

Figure 6. Flowchart for selection of participating teachers and classrooms within the organization

Instruments & Methods of Data Collection

Qualitative and quantitative data were simultaneously collected during the study. There were three methods of data collection in this study: 1. teacher sense of efficacy beliefs surveys, 2. teacher semi-structured interviews, and 3. student social network surveys.

Teacher Sense of Efficacy Beliefs Survey

Sense of efficacy surveys were the first method selected to ascertain the self-efficacy beliefs of teachers. The aim of this method was to partially address the first main research question which is to examine teachers' sense of efficacy around three sub-categories: classroom management, student engagement, and student-centered instruction. An established sense of efficacy survey (see Appendix B) was distributed electronically via Qualtrics to 24 middle school math teachers across the four participating school sites. Informed consent

forms were also electronically sent to all teachers (see Appendix A). Prior to consenting to participate, teachers were informed that the survey was completely voluntary and non-participation would have no negative consequences. The survey results would remain protected and anonymous. In total, 24 teachers responded to the survey, a response rate of 92%. More details on the specific characteristics of these teachers are provided in Table 6, Chapter 4. The first section of this sense of efficacy survey requested demographic data such as a teachers' school site, number of years teaching, grade level taught, experience with lesson study, racial identity, and gender. The following section of the sense of efficacy survey is adapted from Tschannen-Moran & Woolfolk Hoy's (2001) Teacher Sense of Efficacy Scale Short Form. Each statement asked teachers to rate their opinion of agreement or disagreement on a continuum of nine responses, ranging from (1) "none at all" to (9) "a great deal". The data from this survey provided an overarching quantitative snapshot of teachers' sense of efficacy and experience with lesson study in middle school math classrooms in one charter school organization. Factor analysis was used by Tschannen-Moran and Woolfolk Hoy (2001) to test the instrument and three moderately correlated factors were found: efficacy in student engagement, efficacy in instructional practice, and efficacy in classroom management. While a long (24 question) and short (12 question) form of the scale is available, both were found to be moderately to highly reliable. The authors note that there are differences with pre-service teachers and recommend the long form over the short due to factors being less distinct for teachers with less experience (Tschannen-Moran & Woolfolk Hoy, 2001). Since all teachers participating are not pre-service teachers, the short form was selected for efficiency. Questions from the short form scale were written to load for the following groupings:

Efficacy in Student Engagement: Questions 2, 4, 7, 11
Efficacy in Instructional Strategies: Questions 5, 9, 10, 12
Efficacy in Classroom Management: Questions 1, 3, 6, 8

In the study reported in Tschannen-Moran & Woolfolk Hoy (2001), the following reliabilities were found for the short form scale:

Table 4. Sense of Efficacy Short Form Scale Reliabilities

	Mean	Standard Deviation	Alpha
Teachers' Sense of Efficacy Scale	7.1	0.98	0.90
Student Engagement	7.2	1.2	0.81
Instructional Strategies	7.3	1.2	0.86
Classroom Management	6.7	1.2	0.86

Qualtrics was used to distribute the sense of efficacy survey electronically (Qualtrics, Provo, UT).

Teacher Semi-Structured Interviews

From the 24 teacher survey participants, five teachers participated in a follow-up semi-structured sense of efficacy interview (see Appendix D) and their students were invited to participate in a social network survey (see Appendix H). The follow-up interview data provided in-depth insights and analysis of experiences, perceptions, and ideas about lesson study's possible impacts on teachers' sense of efficacy.

Interviews are an established method of collecting and revealing the underlying themes of individuals' lived experiences within systems (Merriam, 2016; Clark & Creswell, 2010). Interviews are necessary to collect data that is normally unobservable such as feelings, thoughts, intentions, and interpretations of events that cannot be easily replicated (Merriam, 2016). Before the interview, the purpose of the study was reviewed and participants had the

opportunity to ask questions about the research. Participating teachers then signed a written consent form to engage in the study as well as be audio taped.

Although fairly new and introduced within the past three years, most teachers in the selected charter organization have experienced being part of a lesson study team. Lesson study cycles generally unfold between 1-2 months. Some lesson study cycles are led by instructional coaches while other lesson studies are composed only of a team of collaborating teachers. Additionally, lesson study structures may vary across cycles and disciplines. Some variations include multiple teachers executing a lesson where other lesson studies have a single teacher instructing. Other variations include a public exhibition of the lesson study while others are conducted with classrooms with only school site teachers. Most of the interviewed focus teachers had participated in a variety of lesson study cycles across math and science disciplines.

As a novice interviewer, it was challenging to comfortably host and accurately document the beliefs, feelings and experiences participants described. In anticipation of that challenge, interviews were audio recorded and later transcribed by an external transcription agency with permission of the participating teachers. To structure the interview, major open-ended questions were first posed regarding teacher experiences with lesson study before follow-up questions were presented. In anticipation of teacher responses, a list of possible follow-up questions were prepared ahead of the interview (see Appendix D). Each teacher interview was listened to and compared to the transcript to check the quality and correctness of transcription.

Student Social Network Survey

A social network survey was administered to students within the classrooms of the five focus teachers who participated in a semi-structured interview. Student survey data provided insight into the networks of student relationships formed in classes where teachers with varying experience levels implement lesson study. In addressing the second research question, the goal is to gain in-depth insights from the five classrooms/cases to understand whether lesson study impacts students' social networks. There were two network questions in the survey, asking students (1) to identify who they ask for help in math class if their teacher is not available, and (2) to identify who they ask for help in humanities class if their teacher is not available. A roster was provided so students only had to check boxes and the survey was distributed electronically via the social network analysis toolkit (Mamas, 2019). For students to participate in the survey, parents and students' informed consent form was sought in line with IRB requirements.

Data Analysis

Teacher Sense of Efficacy Surveys

Teacher sense of efficacy surveys were analyzed with basic descriptive statistics through Qualtrics (Qualtrics, Provo, UT). From the collected teacher efficacy survey data, mean, standard deviation, and variance was calculated and compared for different subgroups of teachers.

Teacher Semi-Structured Interviews

Using an iterative process, interview transcriptions were first open coded to uncover notable themes. After the initial round of open coding, a second round of coding was conducted using the two research questions as a lens for grouping the existing codes. Several

themes emerged from the grouped codes: (1) How do teachers' sense of efficacy change through lesson study? And (2) What lesson study structures inform teachers' sense of efficacy? Codes that were not affiliated with the research questions were discarded. Studying teacher sense of efficacy surveys and student network surveys confirmed and corroborated these themes.

Student Social Network Surveys

UCINET (Borgatti, Everett, & Freeman, 2002) was used to conduct descriptive social network analysis of student social network surveys by developing network visualizations for each classroom and calculating network measures, such as density, centrality and reciprocity (Borgatti, et al., 2018; Mamas, 2019). Social network analysis is primarily concerned with network structure and position of an actor within a network (Borgatti et al., 2018). For example, the structure of a classroom network may be important in understanding the impact of lesson study on students' collaboration patterns, whereas the individual position of students may be revealing of the opportunities available to them to access resources, academic and/or socioemotional support related to math or beyond.

Ethical Considerations & Positionality

A core ethical issue of consideration was the consent of all participants. Participants included teachers, as well as underage children between 11-14 years old. It is important that both teachers and students not only understood the research study but knowingly consented or declined to participate. Accordingly, a letter of assent/consent was shared with all teachers, students, and parents of students to provide more information about the study prior to their participant (see Appendix A, E, F, G). Furthermore, parents and children were assured that all data collected would be treated with confidentiality and used for research purposes. Students,

teachers, and schools' names have been redacted and substituted with pseudonyms or numbers to provide anonymity. Moreover, teachers' permission for audio recording was sought before interview proceedings. It was also made clear to children and teachers that they had the right to withdraw from the research at any time. Research from student network surveys was shared with teachers in a summary report so they were also made aware of student relationships in their classrooms.

Additional considerations included my role as an instructional coach at Hypatia Middle, one of the middle schools within the charter organization and a course instructor at Helix Network Graduate School of Education. As a coach, I interacted periodically with math teachers as I worked to support their instructional practice, co-teach in their classrooms, and design and facilitate professional development opportunities. Although I am not involved in the hiring or retention process, my coaching position may have prevent teachers from being vulnerable in sharing honestly and openly. The role of an instructional coach is to support all teachers in their journey of growth and reflection. Yet many teachers perceived coaches as interventionists, who were selectively working in classrooms with struggling teachers. Therefore, it was critical from my dual role as researcher and coach, I established trust through confidentiality and unbiased language. Teachers were reassured that the purpose of this research was not to evaluate teaching practices or student learning culture. Instead, participating teachers were informed that this research originates from a place of genuine curiosity.

Another equally important ethical consideration was the relationship of power between the researcher and participants. In my work as a researcher, it was critical that I developed a positive relationship with participants. To do this, trusting relationships were

established. Teachers and students were reassured that their participation in this research was optional, confidential, and non-evaluative. At each step in the data collection, participants were offered the option to decline and the purpose of the research was fully explained. This ensured that participants willingly and knowingly chose to engage in the study. Although risk for harm was minimal, it was my ethical responsibility to stop the participation of any subjects, who could potentially exhibit signs of distress. However, I did not have to do this in any case. The health and wellness of participants took precedence over the collection of research data. To ensure the safety of all participants, the Internal Review Board (IRB) at the University of California, San Diego reviewed and approved Project #190372 (see Appendix I).

As an educator and researcher, I hold a commitment to sharing the results of this study to improve teaching beliefs and practices that can ultimately impact the math classrooms of students. I have already started and intend to continue disseminating the results of my study with educators to better understand and improve the impact of lesson study cycles. In addition, I hope the results of this study will be used to improve the efficacy of many math teachers, beyond the four case study schools, so that they may thrive and extend their careers in the classroom.

Summary

This research study employed both quantitative and qualitative methods to explore how and to what extent lesson study impacts mathematics teachers' sense of self-efficacy and the social networks of their students. Within the mixed-methods case study design a pre validated self-efficacy survey was used (Tschannen-Moran & Woolfolk Hoy, 2001) to measure variations in teachers' current sense of self-efficacy. In addition, individual interview

data with focus teachers were collected and coded for themes around how teachers learn from, use, and engage with the lesson study approach and how this impacts their sense of efficacy. Data from student social network surveys were collected from interviewed teachers' classrooms (case study classrooms) to compare teacher perception to actual student experience. Table 5 summarizes the data, instruments, and analysis that were applied to this study.

Table 5. Summary of Data Instruments & Analysis

Instrument	Data to be Collected	Analysis	Informs
Teacher sense of efficacy survey	Likert scale survey data, teacher demographic data	Descriptive statistics	**Research Question 1**: Measure of teachers' sense of efficacy to: ● manage classroom ● engage students ● implement student-centered instructional strategies
Teacher individual semi-structured interviews (30-45 minutes)	Transcription of individual interviews	Thematic Coding	**Research Question 1**: Understanding teachers' experiences with: ● lesson study ● changes in sense of efficacy related to lesson study Measure of teachers' sense of efficacy to: ● manage peer relationships
Student Network Survey	Social network data	Whole social network analysis, Network visualizations, Network measures	**Research Question 2**: Map and measure presence, strength and direction of student relationships

CHAPTER FOUR: RESULTS

Introduction

This research study employed a mixed-methods case study design to explore lesson study in relation to teachers' sense of efficacy and the help-seeking networks of students in math and humanities classes where teachers implemented lesson study. Teacher sense of efficacy surveys from 24 middle school teachers were used to explore teacher's efficacy to effectively (1) manage students, (2) engage students, and (3) implement student-centered teaching strategies. Teacher interviews, similar to teacher sense of efficacy surveys, were conducted to gain in-depth insights into teachers' efficacy around the three aforementioned factors, in addition to (4) managing peer relationships. Semi-structured interviews and sense of efficacy surveys also recorded teachers' experience with lesson study and changes in sense of efficacy through lesson study. Social network surveys were distributed to students from four focus teachers' classes to examine the help-seeking networks of students in math and humanities classrooms.

Interview data from five focus teachers were used to elucidate themes around how teachers experience lesson study and lesson study's possible influences on teachers' sense of efficacy. Data from teacher sense of efficacy surveys and student social network surveys were used to triangulate with emerging themes from the teacher interviews to address the research questions. In what follows, I share the findings of this research study. I first share the findings from the teacher sense of efficacy surveys to address research question 1: how and to what extent can lesson studies influence middle school math teachers' self-efficacy around their ability to effectively: (a) manage students, (b) engage students, (c) implement student-centered teaching strategies. From there I discuss the findings from semi-structured interviews

with teachers and the emerging themes this reveals about middle school math teachers' sense of efficacy in relation to lesson study. This method builds data to address research question 1 and adds to findings on lesson study's potential influence on teachers' sense of efficacy to effectively (d) manage peer relations. Finally, I present the student social network survey data from the five focus classroom teachers to address research question 2: what do the students' help-seeking networks look like in (math and humanities) classrooms in which lesson study approach is implemented.

Teachers' Sense of Efficacy Survey

Anonymous sense of efficacy surveys were the first method selected to ascertain the self-efficacy beliefs of teachers in relation to lesson study. The aim of this method was to partially address the first research question of examining teachers' sense of efficacy around three sub-categories: classroom management, student engagement, and student-centered instruction.

Ethical approval for the project was granted by the Institutional Review Board (IRB) of the University of California, San Diego. Informed consent forms were electronically sent to all teachers (see Appendix A). Teachers were informed that participation was completely voluntary and non-participation would have no negative consequences. Additionally, survey results would remain protected and anonymous. A pre-validated teacher sense of efficacy survey (see Appendix B) from Tschannen-Moran & Woolfolk Hoy (2001) was utilized and data was electronically collected from 24 middle school math teachers across four participating school sites. Originally 25 teachers took the survey but upon cleaning the data, one response was removed due to a teacher starting, stopping, and then restarting the survey at a later time. The response was removed to ensure the teacher's data was not counted twice.

Table 6 provides details on the participating teachers' demographics. Pseudonyms have been used for the four participating middle schools.

Table 6. Middle School Math Teachers Demographics

School Site	**Hypatia Middle School**	**Mirzakhani Middle School**	**Johnson Middle School**	**Robinson Middle School**
6th Grade Teachers	2*	1	1	2*
7th Grade Teachers	3	2	2	3
8th Grade Teachers	2*	2*	2*	2
Total Teachers	7	5	5	7
Gender	Female - 4 Male - 3	Female - 4 Male - 1	Female - 2 Male - 3	Female - 2 Male - 5

*Includes focus teachers

In a sample of 24 middle school math teachers, 16 of the teachers had experienced fewer than 5 cycles of lesson study. Yet 17 of the 24 teachers had 5 or more years of teaching experience.

Table 7. Middle School Math Teachers Experiences with Lesson Study

Cycles of Lesson Study	**1-2**	**3-4**	**5-6**	**7-8**	**9-10+**
# of Teachers	9	7	2	1	5

Table 8 shows that math teachers in this sample had a range of years of teaching experience but no teachers surveyed were in their first year of classroom teaching.

Table 8. Middle School Math Teachers Years of Teaching Experience

Years of Teaching Experience	**2**	**3-4**	**5-6**	**7-8**	**9-10+**
# of Teachers	4	3	6	4	7

Using the Teachers' Sense of Efficacy Short Form Survey (Woolfolk Hoy & Tschannen-Moran, 2001), teachers were asked to respond to twelve questions using a Likert scale ranging from (1) "none at all" to (9) "a great deal". Each question asked teachers to consider the combination of their current ability, resources, and opportunities to do each of the following in their present position. Table 9 shows the descriptive statistics of surveyed teachers' responses to twelve short form questions.

Table 9. Middle School Teachers' Current Sense of Efficacy Survey Data

Survey Question	Minimum	Maximum	Mean	Standard Deviation	Variance
1. How much can you control disruptive behavior in the class?	4	9	7.29	1.27	1.62
2. How much can you do to motivate students who show low interest in school work?	5	9	7.33	1.03	1.06
3. How much can you do to calm a student who is disruptive or noisy?	5	9	7.38	1.15	1.32
4. How much can you do to help your students value learning?	5	9	7.54	1.12	1.25
5. To what extent can you craft good questions for your students?	4	9	7.17	1.14	1.31
6. How much can you do to get children to follow classroom rules?	4	8	7.08	1.11	1.24
7. How much can you do to get students to believe they can do well in school work?	5	9	7.63	0.86	0.73
8. How well can you establish a classroom management system with each group of students?	3	9	7.00	1.29	1.67
9. To what extent can you use a variety of assessment strategies?	5	9	7.54	1.22	1.50
10. To what extent can you provide an alternative explanation or example when students are confused?	4	9	7.75	1.20	1.44
11. How much can you assist families in helping their children do well in school?	3	9	6.33	1.34	1.81
12. How well can you implement student-centered teaching strategies in your classroom?	3	9	7.08	1.32	1.74

Factor analysis was used to test Tschannen-Moran and Woolfolk Hoy's Teachers' Sense of Efficacy Survey (2001) and found to consistently have three moderately correlated factors: efficacy in student engagement, efficacy in instructional practices, and efficacy in classroom management. A 12-item short form and a 24-item long form of the survey are available. The long form survey is recommended for preservice teachers because the factor structure often is less distinct for these respondents. Since only one teacher out of the 24 teachers who responded is a preservice teacher, the short form survey was selected and implemented.

To determine the efficacy in student engagement, efficacy in instructional practices, and efficacy in classroom management subscale scores, unweighted means of the items that load on each factor were computed (Tschannen-Moran & Woolfolk Hoy, 2001). Generally, these efficacy subscale groupings are:

Student Engagement: Items 2, 4, 7, 11

Instructional Strategies: Items 5, 9, 10, 12

Classroom Management: Items 1, 3, 6, 8

In the study reported in Tschannen-Moran & Woolfolk Hoy (2001), the following reliabilities (see table 10) were found for the Teachers' Sense of Efficacy Short Form Survey. While similar teacher efficacy scores were collected from the sample of 24 middle school math teachers, a difference in mean management is present. Additionally, the standard deviation of overall teacher sense of efficacy scores and instruction were greater for the sample of 24 teachers than the original sample of teachers from Tschannen-Moran & Woolfolk Hoy's (2001) survey.

Table 10. Teachers' Sense of Efficacy Short Form Efficacy Subscale Reliabilities

	Teachers' Sense of Efficacy from Tschannen-Moran & Woolfolk Hoy (2001)			Collected Teachers' Sense of Efficacy		
	Mean	**Standard Deviation**	**Alpha**	**Mean**	**Standard Deviation**	**Variance**
Teacher Sense of Efficacy Score	7.1	.98	.90	7.3	1.2	1.59
Engagement	7.2	1.2	.81	7.2	1.2	1.49
Instruction	7.3	1.2	.86	7.4	1.3	1.79
Management	6.7	1.2	.86	7.2	1.2	1.49

Although the original teacher sense of efficacy survey from Tschannen-Moran and Wolfook Hoy (2001) employed exploratory factor analysis to find three correlating factors, I have selected to not apply factor analysis for my sample. For factor analysis, it is recommended that samples are selected randomly so they represent the studied population and their results can be generalized (Tabachnick & Fidell, 2013). Since the 24 middle school teachers were intentionally selected, they are not random and the sample size is too small to reflect a much larger middle school math teacher population. Additionally, factor analysis is recommended when researchers have a theory about potential underlying factors (Tabachnick & Fidell, 2013). Due to these considerations, I chose to focus only on descriptive statistics of the sample size.

To identify possible influences of lesson study on teachers' sense of efficacy scores, the mean values of two subcategories of teachers were calculated; teachers with 1-2 cycles of lesson study experience and teachers with 8-10+ cycles of lesson study experiences (see Table 11). I selected these two subcategories since they represented opposing ends of the lesson study experience spectrum. Teachers with 1-2 cycles of lesson study experience had a range

of years of teaching experience from 2-10+ years. Teachers who had 8-10+ cycles of lesson study experience had a range of 3-10+ years of teaching. While lesson study experience may not be the only factor influencing teachers' sense of efficacy, an effort was made to ensure teachers' years of experience was not the predominant influencing factor. Table 11 displays the mean efficacy scores of each subgroup of teachers.

Table 11. Teachers' Sense of Efficacy Averages

Mean Values	**Teachers with 1-2 cycles of lesson study experience**	**Teachers with 8-10+ cycles of lesson study experience**
Teacher Sense of Efficacy Score	7.14	7.67
Student Engagement	7.18	7.58
Instructional Strategies	7.13	7.71
Classroom Management	7.13	7.71

From the surveyed sample, teachers with more lesson study experience generally reported slightly higher levels of efficacy across all three categories including student engagement, instructional strategies, and classroom management.

Impact of Lesson Study on Teacher Sense of Efficacy: Interview Findings

To develop an in-depth understanding of lesson study's impact on teachers' sense of efficacy, I selected and focused on five teachers as cases. Originally, I proposed having six focus teachers but with time constraints and scheduling conflicts, only five teachers were able to participate. The five teachers were identified based on their experience with lesson study (number of cycles participated in), the number of years they have taught mathematics, and their school campus. A scattering of experiences, in addition to different teacher genders and ethnic backgrounds, were intentionally selected to provide a diverse voice of the experiences

with lesson study. Some teachers have experienced only a few rounds of lesson study and are in the first few years of their teacher careers while other teachers have over 10 years of experience and have experienced multiple rounds of lesson study.

The five teachers participated in a follow-up semi-structured interview to provide an in-depth analysis of experiences, perceptions, and ideas about lesson study's possible impacts on teachers' sense of efficacy. In alignment with IRB requirements, teachers provided consent to be interviewed and major open-ended questions with personalized follow-up questions were posed regarding their experiences with lesson study (see Appendix D). Their interviews were audio recorded and full transcripts were developed. Thematic analysis was then applied to code, identify, review, and refine themes from the teacher transcripts.

Analysis of teacher survey and interview data, revealed four main themes around the research question: How and to what extent can lesson studies influence middle school math teachers' sense of efficacy around their ability to effectively (a) manage students, (b) engage students, (c) implement student-centered teaching strategies, and (d) manage peer relations (see Table 12).

Table 12. Emerging Themes from the Analysis of Qualitative & Quantitative Data around Teacher Efficacy in Relation to Lesson Study

Changes in teachers' sense of efficacy through lesson study
Theme 1: ● Fluctuations and trends in teachers' sense of efficacy
Theme 2: ● Bandura's four sources of information that influence teachers' sense of efficacy
Theme 3: ● Teachers with lesson study experience express increased sense of efficacy
Lesson Study Structures that Inform Teacher Sense of Efficacy
Theme 4: ● Lesson study structures that inform teacher sense of efficacy

Table 13 lists the focus teachers, identified by pseudonyms, and their demographic data. The five focus teachers are Carlos, an African-American man, Laura, a Mexican-American woman, Mike, a European-American man, and Brielle and Kesha, both European-American women. Each teacher had a minimum of 3 years of teaching experience and had at least one experience with lesson study. All teachers were also participants of the district's Mathematical Agency Improvement Community (MAIC). All but one of the five focus teachers also taught science. The district's science department referred to as the Next Generation Science Standards (NGSS) initiative also utilizes the lesson study approach so most middle school math and science teachers have experienced lesson study in two content disciplines.

Table 13. Focus Teacher Demographics

Demographic Category	Brielle	Carlos	Laura	Mike	Kesha
Gender	F	M	F	M	F
Grade Level	6th	6th	8th	8th	8th
Subject	Math/Science	Math/Science	Math/Science	Math/Science	Math
Ethnicity	European-American	African-American	Mexican-American	European-American	European-American
Years of Teaching	8	10	3	19	8
Cycles of Lesson Study	3	10+	6	1	7

Changes in Teacher Sense of Efficacy Through Lesson Study

Theme 1: Fluctuations and Trends in Teachers' Sense of Efficacy

Teachers' sense of efficacy is not always consistent and can fluctuate based on daily experiences. With more mastery experiences, veteran teachers with 9-10+ years of experience reported higher mean levels of efficacy to manage, instruct, and engage students than novice teachers with only 1-3 years of teaching experience. Yet, efficacy scores can range even with teaching experience. Beginning teachers with 1-3 years of teaching experience had a mean efficacy score of 6.5 versus veteran teachers with 9-10+ years of experience had a mean efficacy score of 7.7. Beginning teachers also had a larger range of efficacy scores in comparison to veteran teachers. For example, on survey question 8: How well can you establish a classroom management system with each group of students, beginning teachers with 1-3 years of experience responded with a range of scores from 3 to 9 while veteran teachers with 9-10+ years of experience responded with a range of scores from 7 to 8. Kesha hypothesized why some beginning and veteran teachers may sometimes report similar

efficacy scores. “As a veteran, I’m also sometimes hyper-aware of the ways in which I’m still not doing it . . . and so I think as you get more effective, you also become more aware of the ways in which you’re not effective.” Kesha continued by reflecting on how her sense of efficacy has changed over her teaching career. “I am definitely more effective at those things now in year eight than I was in year two. And I think that novice (teachers) are likely to overrate themselves.”

Additionally, Brielle expressed her wavering efficacy related to instruction and engagement. “I think it’s really hard. I would say I can facilitate (math) discussions, but I don’t know how well they translate into every student benefiting from them.” As a veteran teacher with 8 years of teaching experience, Brielle has been both a humanities and mathematics teacher. She describes the unique challenges of facilitating learning in each content class.

> Coming from a humanities background, that feels a little different because in humanities we’re talking about opinions, where nobody has necessarily a wrong answer, whereas in math, you can be wrong. I think it’s really scary for kids and keeps them from speaking up a lot of times.

Mike shared Brielle’s sentiment as experiencing efficacy that “ebbs and flows” based on the execution of daily lessons. Kesha agreed by describing how her sense of efficacy, while generally high, can easily shift to leave her with feelings of doubt. “I feel that tension constantly because I feel confident and like a great teacher. And then, also, there are days where I’m like a terrible teacher.”

Theme 2: Bandura’s four sources of information that influence teachers’ efficacy

Bandura (1986, 1997) proposed four factors that impact teachers’ sense of efficacy; mastery experience, vicarious experience, social persuasion and affective states. From teachers’ semi-structured interviews, the four factors in relation to lesson study were

repeatedly referenced. Mastery experiences and vicarious experiences seemed to be more heavily weighed than social persuasion and affective states since they were most frequently discussed in teachers' interviews about lesson study.

Mastery experiences. Of the four factors identified by Bandura (1986, 1997) to increase teacher efficacy, mastery experience is believed to be the most significant because these experiences resulted in higher teacher confidence from their observations of the impact of instruction and student performance. Throughout their careers, teachers inevitably will experience successes and failures. The perception that a performance has been successful raises efficacy beliefs, contributing to the expectation that performance can be repeated and will be proficient in the future. The perception that one's performance has been a failure lowers efficacy beliefs, contributing to the expectation that future performances will also be inept. Kesha described how her public lesson study left her with a diminished sense of efficacy, "I felt so much anxiety going back to my public lesson study. I was reliving the trauma of it and it was so bad. Things didn't go as planned and that didn't feel good. I felt like I had failed as a teacher and presenter." Although Brielle experienced an increase in efficacy with her lesson study in comparison to Kesha, she confirmed that mastery experiences have significant impacts on teacher efficacy beliefs. "But the lesson study that we planned I felt like was really good because it allowed for some time of class discussion and kids to work on their own on a hands-on activity. And I feel like I got a lot from the lesson study." With an increase in efficacy from observing her students actively engaged in the lesson, she felt confident to repeat the practice after the lesson study concluded. "I learned new discourse strategies that work for me and I know I can keep using in my classroom."

Vicarious experiences. Although the act of teaching is mostly done in isolation,

teachers regularly interact outside their classrooms. Through these interactions, such as lesson study, teachers learn about and directly observe other colleagues' achievements. These vicarious experiences can be powerful influencers of increased teacher efficacy. Kesha described being inspired watching Carlos' public lesson study. "When I watched (Carlos') lesson public lesson study, I mean, it was so good. That was so much better that he asked that question and not the one I had planned."

When teachers observe similar teachers of perceived ability, within similar contexts, experience instructional success, they are more likely to believe that these experiences are replicable within their own classrooms (Bruce et al, 2010). While Brielle identified mathematics discourse and instruction as being more challenging to facilitate, her sense of efficacy has improved with lesson study.

> (Lesson study) helps with teaching to the spectrum of kids, that the ones that maybe that maybe are struggling, a little bit harder, they see that strategy, and the kid that gets their strategy highlighted feels more confident going into it. So I think that's definitely a strategy I gained from the lesson study modeling experience.

Like Brielle, Carlos stated the importance of observing and experiencing student-centered instruction through lesson study prior to attempting the same structures in his classroom. "I could not have done it without seeing it being done. And so I needed to experience things with lesson studies, I get to see and I get to participate." When Brielle and Carlos perceived the learning context to be similar to their own teaching situation, their efficacy in applying similar strategies increased. The more removed the situation appeared, the less efficacy they experienced. Brielle reflected on her first professional development experience by stating:

> When (she) modeled (the lesson) she would want in the classroom, that feels like a completely different story than with 28 sixth graders instead of 12 adults in the lesson. You don't have any classroom management struggles in that scenario . . . I felt like that alone wasn't doable for me for an entire class period like what she modeled.

Brielle then contrasted her prior professional development experience to her experience with a subsequent lesson study.

> The lesson study that we planned I felt like was really good because it allowed some time for class discussion and kids working on a hands-on activity. I felt more confident after facilitating that lesson study. Plus, I think seeing someone else teach the same lesson that you're teaching gives you maybe ideas that you wouldn't have thought of on your own.

Social persuasion. Professional development, instructional coaching, and social media can also influence teacher efficacy. Simply being exposed to successful models is not enough to aid in change or have lasting results on teacher efficacy. Instead, social persuasion coupled with positive direct experiences can motivate teachers into action. Carlos explained how the social persuasion of an instructional coach and his principal did not solely define his efficacy but did influence his motivation to continue growing, "I feel more confident now as a teacher. (She) says my practice has definitely improved since I first started compared to now. She'll say, 'You're very close to being a master at it,' and I was like, 'That's something exciting to say, because I don't feel that way.' That really pushes my enthusiasm to get better."

As a veteran teacher with 10+ years of teaching experience but only one cycle of lesson study completed, Mike described his vicarious experience of observing an instructional coach as inspiring but not resulting in an increase of his sense of efficacy. While he valued the routines he observed, he did not have confidence in recreating the same discourse-based learning environment. "It's challenging but it ebbs and flows. Sometimes it's great. Sometimes it's awful. And that's probably part of me needing to improve my skill in that

too." Mike reflected on the experience of working with an instructional coach as aspirational but not yet within the realm of his current skill set.

Affective states. An individual's emotional state of being can directly impact their perception of future success. Feelings of stress, depression, and tension can negatively affect individuals as well as organizations. By reducing an individual's negative emotional state and helping them reframe their perspective and interpretation of feelings, teachers are more likely to increase their efficacy. Kesha identified the practice of lesson study as healing, "Being part of a group of teachers who are also trying to be reflective and improve their practice is really healthy and uplifting. Teaching can be really isolating, even in a school like ours."

Theme 3: Teachers with lesson study experience express increased sense of efficacy

Overall, teachers identified lesson study as a positive influence in building their sense of efficacy to effectively manage classrooms, engage students, and implement student-centered instruction. When asked if lesson study impacted her efficacy to create student-centered classrooms, Kesha stated that it did. Yet she identified lesson study as being especially influential when she experienced a low sense of efficacy as a beginning teacher.

> If I answer big-picture, then yes. But I especially point to my experience in Washington DC, that group of teachers, and especially the coach who led us was important to my development. I had a really terrible first couple of years of teaching. And I was not a great teacher. I was ill-prepared.

Like Kesha, Carlos shared that lesson study supported his growth in efficacy to implement student-centered strategies. He now feels "very prepared" in comparison to his beginning years in the classroom. Carlos identified lesson study's focus on student thinking as being crucial to helping him better engage students and manage a diverse classroom of learners. "Kids will get the most learning and the best experience if you keep the learning on

them. If you keep them carrying the cognitive load and keep them discussing, keep them thinking critically . . . it allows you to be able to hit a full range of all of your students."

Although she is a beginning teacher with 3 years of teaching experience, Laura stated that she also felt "well prepared" to manage and engage learners of diverse backgrounds. Laura explained that observing other teachers pushed her to consider how to use the same practices in her own classroom. "I find that exposure really helpful just to see someone else doing it and think about, 'Okay, these are the things I want to do or these are the types of questions or even really the type of demeanor.' Laura said that lesson study increased her sense of efficacy because she wasn't expected to replicate a lesson or a teaching style. Instead, Laura said her confidence grew when she understood how and why students responded to a teachers' instruction. "(The students)' way of thinking about problems has changed my thinking about problems. If I understand that, then I'm better prepared to support them." Even though Laura values lesson study as professional development, she admits that she still has moments of wavering efficacy.

> Obviously, I think I have a lot of ways to grow especially when it comes to whole-class discussions. I feel like I always really struggle with that. And making kids feel comfortable sharing their ideas I think is really challenging. So I don't feel like I'm an expert, yet.

While teachers with lesson study experience expressed increased levels of efficacy around classroom management, student-centered instruction, and student engagement, they did not identify lesson study as having an impact on their efficacy to manage student relationships. In her interview, Laura stated that lesson study focused more on student thinking than student interactions. "I feel like lesson study has been more focused on the content and how students are understanding the content, misconceptions, and connections,

and things like that and not as much with the safety of the room." When asked about her efficacy to influence student relationships, Brielle struggled to identify factors that may influence student relationships in and out of the classroom.

> I am not sure if I can pinpoint specific things that I'm doing or (my teaching partner)'s doing to facilitate friendships among kids. I think we're really good at having really good relationships with kids, and maybe that translates to them having good relationships, but I don't know that I'm specifically trying to facilitate friendships among them.

Similarly, when Kesha was asked about lesson study's potential influence on her efficacy to manage student relationships, she stated that it did not.

> No—we don't really talk about (student relationships) in lesson study. And I think because you're planning a lesson, the conversation you have ends up being more around lesson structures or even management structures or routines and not as much on relationship building.

However, Kesha did identify lesson study as influential to her efficacy of creating a positive classroom culture which she saw indirectly tied to student relationships.

> I do things like that to try to elevate voices and to encourage positive productive relationships at their tables. And with the whole class, if someone says something and then the class reacts one way, I know how to make a big deal about-- using my power to change the dynamic or offer sentence stems for ways to respond when we disagree, or lots of things like that. Yeah, I definitely try to help. But that's more like, I guess, culture building to me and less friendship-building, more like, 'I don't care if you like each other or not. But you will be nice to each other. You will respect each other.'

Carlos agreed that lesson study may have an "indirect relationship" on his efficacy to manage student interactions. He described strategies and practices he'd learned through lesson studies and other professional development opportunities that equipped him to attend to issues of status and power in student networks. Carlos provided other indirect examples of managing student relationships when he described students observing teachers model collaboration through the lesson study approach.

> If (students) are seeing teachers who are very supportive of each other, it's like a mirror. . . I do think that the lessons that we implement for lesson studies allows them to always tend to work and talk to each other. So they start to see these things with each other and building connections with each other.

Lesson Study Structures that Inform Teachers' Sense of Efficacy

Theme 4: Lesson Study Structures that Inform Teachers' Sense of Efficacy

Focus teachers commonly identified three structures, namely of lesson study that influenced their efficacy to effectively engage students, manage classrooms and utilize student-centered instruction. The three structures referenced include (1) the framing of lesson study, (2) a student-centered focus, and (3) a situated context for professional learning. In discussing these structures, overlap was noted as teachers often described multiple structures that collectively influenced their efficacy.

Lesson Study Framing. Teachers with varying experiences of lesson study cycles identified different purposes of lesson study. This contrast in the perceived purpose of lesson study also revealed a variation in teacher efficacy.

With only one cycle of lesson study experience, Mike described lesson study as a collaborative process of teachers designing a lesson culminating in teacher(s) "performing that lesson with students in front of an audience so that the audience sees the teacher tricks, sees the style of questioning and sees the desired outcomes of the planned lesson." Mike struggled to balance the value of lesson study in comparison to the time commitment required. "Lesson study takes weeks to plan. So by the time you actually execute the content, the class has probably moved on." Mike continued and explained how lesson study felt inauthentic to his current classroom of students. He perceived the resources required to design the lesson as investments for future learning.

> You're revisiting this (lesson), which isn't bad to revisit, but you're revisiting in an inauthentic way. You're doing it more for show purpose, not for the kids. But those specific kids, I feel like it's an inauthentic experience but powerful because they're part of something bigger.

While Mike perceived the purpose of lesson study as planning for a single lesson and observing teacher moves, teachers with more lesson study experience described an alternative purpose of lesson study. In contrast to Mike, Laura saw lesson study as an opportunity to learn helpful strategies, structures, and routines for student-centered learning.

> Because you end up with one lesson, (what) you really want to do is develop a structure or routine that's going to happen regularly because that's what really has the most impact. But I think it's easy for that to get lost when you're really focused on the one lesson.

Laura stated that her understanding of the purpose of lesson study had shifted with experience. Instead of viewing lesson study as a need to produce a single, flawless math lesson, she now saw lesson study as an opportunity to learn about student mathematical thinking.

> The goal is more through the process of teachers regularly getting together, talking about teaching, talking about student thinking -- that's what really creates the learning rather than, 'And then we made this really nice lesson to use again.

Agreeing with Laura, Carlos identified the purpose of lesson study as an opportunity for teachers to focus on "thinking about students' misconceptions, how students are going to think about the math problem."

This shared lesson study purpose was also highlighted by Kesha when she discussed the importance of seeing the connection between teacher behavior and student responses in lesson study. Unlike Mike, Kesha did not view the purpose of lesson study as an observation of teacher performance. Instead she described how lesson study shaped her efficacy to

perform similar tasks in her classroom. “I see the ways in which the structures that I also use don’t hold them to a high enough expectation or don’t give them a thing to do in that space.” When asked why lesson study had a greater impact on her efficacy and growth as a teacher than traditional professional development, Kesha stated that observing student thinking in response to teacher behavior reinforced her willingness to use the observed practice in the future.

> How the students actually approach the math compared to how you anticipated they would approach the math and how they react to some of the moves that you planned. And you get to really get closer to student thinking and see things from the student perspective. And then you get to debrief altogether and think about how the things you did impacted what happened for the students.

While most focus teachers reported generally positive levels of efficacy, they attributed their sense of efficacy to different factors. Kesha, Laura, and Carlos shared a common perceived purpose of lesson study and often referenced their learnings from lesson study approach as a factor for influencing their efficacy around management, student engagement and student-centered instruction. Mike identified an alternative purpose of lesson study and while he did express generally positive sense of efficacy, he attributed his efficacy and growth as a professional to positive mastery experiences, observation of peers, and utilization of professional development resources. Mike reflected on his attempts at facilitating a lesson including student discourse:

> Getting kids to talk about their thinking and their strategies so that others who typically struggle can listen and hear in on that. And getting kids who are really good at just the calculation, pen and paper, giving them practice to verbally articulate, I think it’s great. And so I feel like I’m good on a basic level. But then when I get the kids who have shown me nine different ways that they’ve done it, I’m not sure where to go from that. . . So I always really struggle with deep follow-up questions. That’s kind of where I struggle, is the really in-depth talk.

Even though Mike valued the student-centered practices presented through the organization's Mathematical Agency Improvement Community (MAIC), he expressed a wavering efficacy in effectively engaging students and the most hesitation to continue the student-centered instructional practices.

Push for Furthering Student-Centered Practices. As a collective planning team, lesson study pushes teachers to strive for student-centered instruction and structures beyond their current range of practice. Kesha identified that by "emphasizing (student-centered instruction) and making it a focus," lesson study has forced her to attempt new instructional practices and routines beyond her current scope. "I think the thing that helped me most was making myself do it and feeling it out." By taking the first step through lesson study, Kesha is "starting to feel more comfortable" with student-centered and discourse-based instruction. Brielle added that lesson study encouraged her to build a community of diverse learners which she struggled to do previously on her own.

> And I think that that aspect of (lesson study) helps with teaching to the spectrum of kids, that the ones that maybe are struggling a little bit harder, they see that strategy, and that kid that gets their strategy highlighted feels more confident going into it. So I think that's definitely a strategy that I gained from lesson study experience.

Yet when a lesson study did not go as planned, not all focus teachers experienced a decline in efficacy. The process of learning together helped Carlos feel less discouraged when he did not effectively execute his instructional routine. "I think you can learn so much by observing, talking, and working with each other without the sense of punishment." For Carlos, lesson study's power and influence on teacher efficacy comes from the debrief process after the lesson has been taught.

> When we unpack what students are thinking and then unpacking how the lesson went from our own observations and thinking of ways to better or make tweaks to the lesson, and then also focusing that, again, based on the students thinking, how to best do that and help them learn more or unpack more, whatever we're trying to gain, I think the debrief element, to me, was the most impactful in my practice and confidence.

When asked about lesson studies that did not follow the anticipated plan, Carlos explained that the debrief with participating teachers allowed him to rebuild his confidence and understanding of his pedagogy. This new understanding made him more certain that the attempted routine or skill could be effectively applied in future lessons.

Situated Context. Another key structure of lesson study that influenced teachers' efficacy was learning within the classroom context. A lesson is collaboratively planned with a cohort of teachers who observe the lesson unfold in real time with real students. In comparison to traditional professional development, lesson study is situated with actual classrooms which reinforces teachers' mastery and vicarious experiences. Brielle contrasted traditional professional development and lesson study by first describing her experience with an instructional coach hired by her school site to provide professional development for teachers. "She's modeling a lesson, and we're adults, and we can easily have a conversation, models what she would want in a classroom, but that feels like a completely different story with 28 sixth graders are in the classroom when I'm teaching the lesson." By removing students, Brielle did not perceive the modeled lesson as realistic or applicable to her own practice. "you don't have any classroom management struggles in that scenario, where when you're in the classroom with 28 kids, you're dealing with kids not wanting to share, kids not knowing what to do, kids not respecting whoever is speaking, because they're having side conversations."

Lesson Study Impact on Student Help-Seeking Networks in Mathematics

To study what students' help-seeking networks look like in mathematics classrooms where lesson study approach was implemented, I collected student social network survey responses from four focus teachers' math classrooms. Ethical approval for the project was granted by the University of California, San Diego Institutional Review Board (IRB). Informed consent forms were sent to all parents (see Appendix E). In line with IRB requirements, each participating student also had to sign the adolescent consent form (see Appendix F & G). It was made clear to parents and students that participation was completely voluntary and non-participation would have no negative consequences. To examine the help-seeking networks, students were provided with an electronic roster and asked to select the classmates they ask for help if the teacher is not available. The social network survey had two relational questions. The first one asked students 'in math class, who do you ask for help if your teacher is not available?' and the second question asked 'in humanities class, who do you ask for help if your teacher is not available?' Both questions were followed with the prompt 'please select as many classmates from the list below'. The electronic survey (Mamas, 2019) was administered by the researcher to answer any clarifying questions from the participants with the classroom teacher present.

Although I aimed to focus on describing the help-seeking networks of mathematics classrooms, I also collected data on the help-seeking networks in humanities classrooms. This data provided an opportunity to contrast the help-seeking networks in mathematics to other social networks of students. While I collected student social network survey responses from four focus teachers' classrooms, five classroom networks will be described since one of the four teachers volunteered to have two of her math classes participate. Originally, I proposed

to have six focus student teachers but due to restraints on time and availability, four focus teachers were available. Across the five classrooms, classroom sizes ranged from 25 to 29 students, with an average of 26.8 students per class. Social network data requires a minimum response rate of 75% to 80% to be reliable (Mamas, 2019; Neal, 2008). Of the five surveyed classes, there was a range of 79 to 100% response rate and an overall average response of 89.6%.

Table 14. Focus teachers' math classroom survey response rates

	Grade	# of students	# of student responses	% of student responses
Brielle's Class A	6	26	24	92%
Brielle's Class B	6	29	29	100%
Carlos' Class	6	26	22	85%
Mike's Class	8	25	23	92%
Kesha's Class	8	28	22	79%
Averages	--	26.8	24	89.6%

Social Network Measures

Within social network analysis, degree centrality shows the total number of ties to or from an individual (Daly, 2010). Based on student responses to the help-seeking and friendship survey prompts, the average degree was calculated for each class. An individual's in-degree centrality is determined by the ratio of realized ties to possible ties with others in the network. In a social network map, in-degree centrality is expressed by the size of the node representing an individual. A larger node shows that the individual is more centrally connected versus a smaller or isolated node with fewer connections. Based on student responses, I mapped the indegree centrality for class networks as seen in figures 6 through 9.

For non-symmetric data, in-degree centrality is calculated by the number of nominations received which are not necessarily reciprocated (Daly, 2010). In contrast, out-degree centrality is calculated based on the number of nominations sent out to individuals in the classroom but do not necessarily have their ties returned to the total number of possible relationships. Table 15 below shows the average degree centrality of student networks in mathematics and humanities across the focus classrooms, as well as teachers' years of teaching experience and cycles of lesson study. Students in each class travel together and have a separate mathematics and humanities teacher. Each class is labeled by their math teachers' pseudonym.

Table 15. Average Degree Centrality of Student Help-Seeking Networks

	Mathematics Avrg. Degree	**Humanities Avrg. Degree**	**Years of Teaching Experience**	**Cycles of Lesson Study**
Brielle's Class A	4	3.962	8	3
Brielle's Class B	2.931	2.345	8	3
Carlos' Class	3.231	2.654	10	10+
Mike's Class	2.480	2.240	19	1
Kesha's Class	2.750	2.107	8	7

While the average degree in sample classrooms ranged from 2.240 to 4 connections, mathematics classrooms had consistently higher values of average degree regardless of the number of lesson studies experienced by the focus teacher. Figures 7 and 8 display student social networks from Kesha's 8th grade humanities and mathematics class. The direction of the arrow points to the individual who was identified as a resource. The more arrows directed at an individual results in a larger node and shows higher in-degree centrality. Arrows that point in both directions show a connection between individuals who sought each other

mutually helpful (reciprocated tie). The length of arrows and distance between nodes is not an indication of any factor. The colored nodes in the network map represent students' gender; a pink node indicates a female student and a blue node indicates a male student.

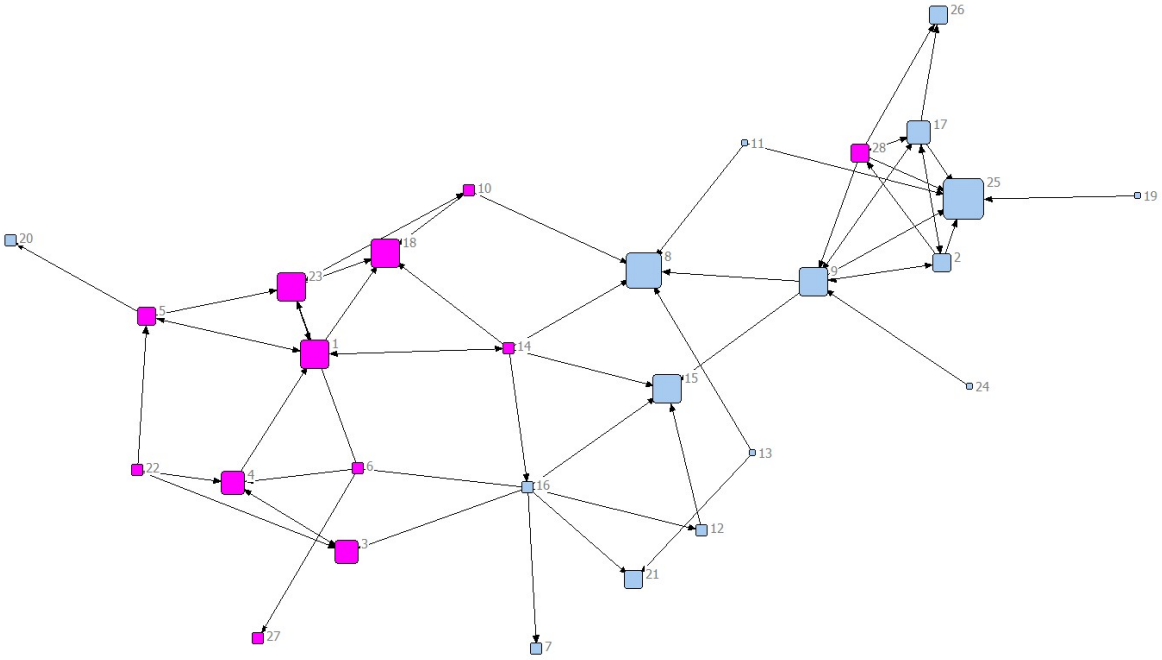

Figure 7. Kesha's Help-Seeking in Humanities Social Network Map

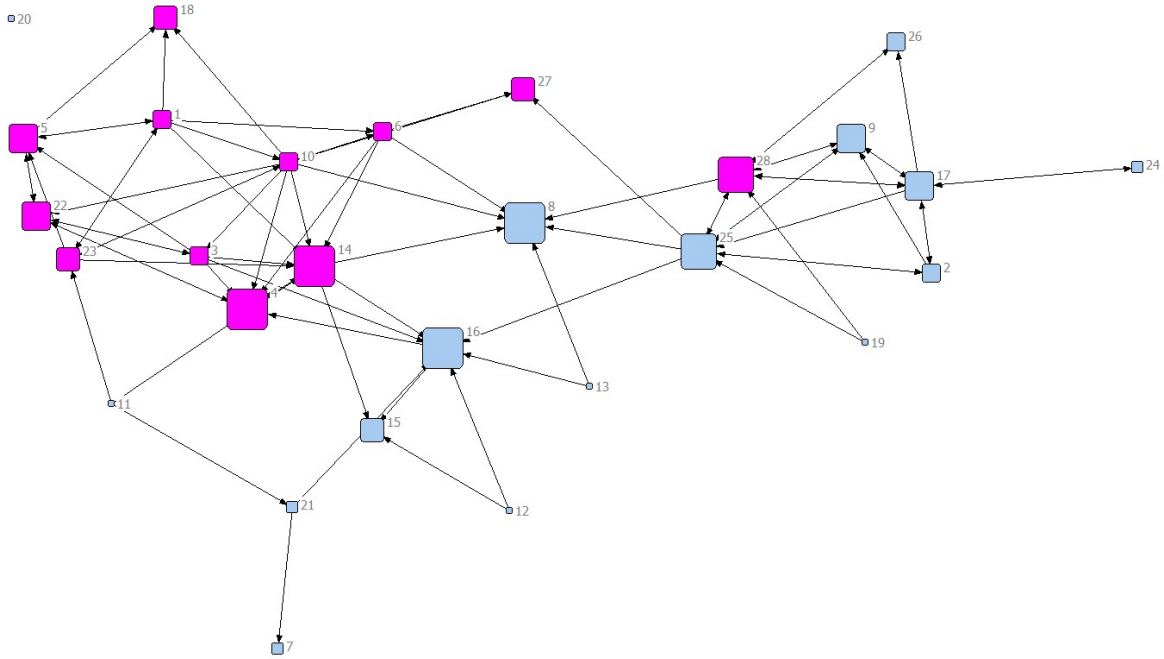

Figure 8. Kesha's Help-Seeking in Mathematics Social Network Map

When comparing the average degree centrality scores of humanities to math classrooms, math teachers with more lesson study experience generally displayed greater differences than their peers with less lesson study experience. However, humanities teachers also have a range of years of teaching experience, types of professional development, and teaching philosophies. This may or may not be reflected in the social networks of their humanities classrooms. In Kesha's math and humanities classrooms, higher in-degree and out-degree centrality was present in mathematics than in humanities. Yet some consistencies in the two networks did emerge. Students who were central in mathematics were generally central in humanities. Additionally, students who had one or fewer ties in humanities also had one or fewer ties in mathematics. These more isolated students were predominantly Hispanic, American Indian, or African American males. Many isolated students also qualified for free or reduced lunch prices and/or special education services.

Figure 9 and figure 10 show the network maps in Mike's 8th grade math classroom and Carlos' 6th grade math classroom, based on in-degree centrality.

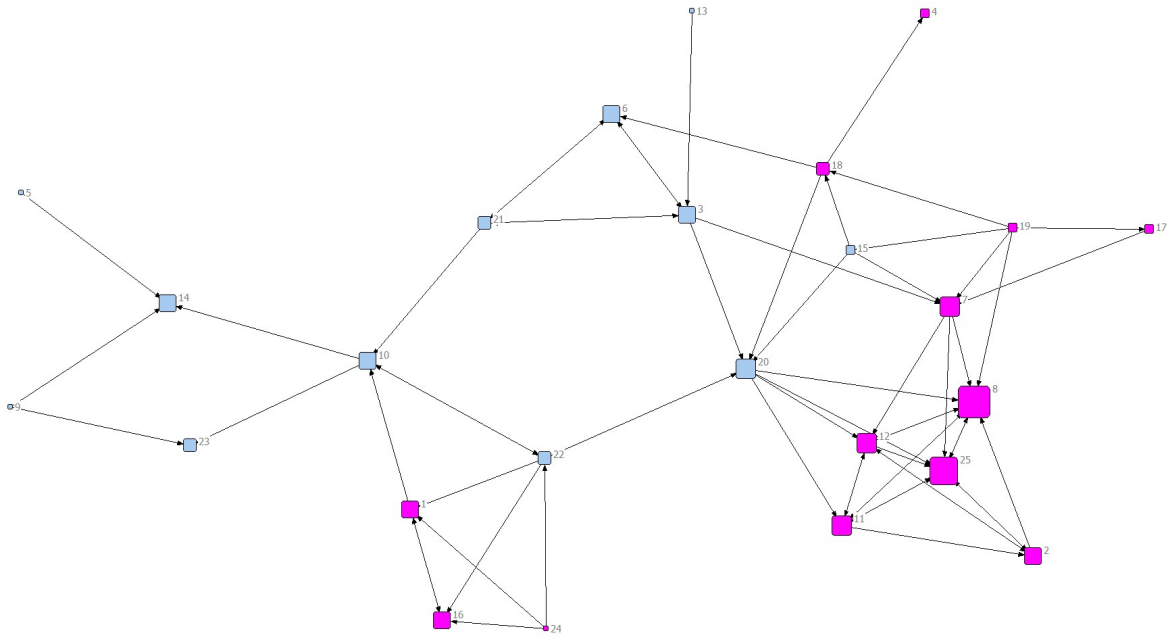

Figure 9. Mike's Help-Seeking in Mathematics Social Network Map

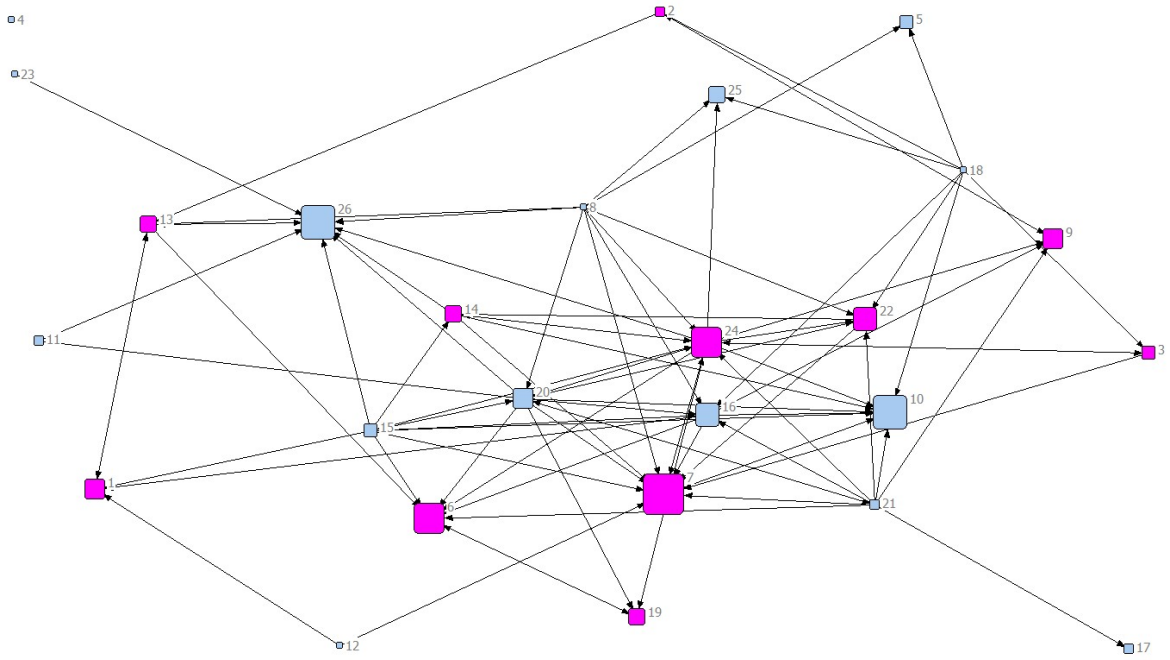

Figure 10. Carlos' Help-Seeking in Mathematics Social Network Map

While the total number of ties is greater in Carlos' classroom than in Mike's classroom, I also note the demographics of the centrally connected and isolated students. Mike's students with highest centrality include 3 Caucasian females, 2 Caucasian males, and 1 Hispanic female. Carlos' students with highest centrality include 1 Hispanic female, 1 Filipino female, 1 Caucasian male, 2 Hispanic males and 1 Caucasian female. Although the average number of relational ties was higher in Carlos' math class than Mike's math class, some similarities did emerge. In both Carlos' and Mike's math classes, students with one to no ties were predominantly of Hispanic, African-American, or American Indian descent and qualified for free-reduced lunch. Additionally, students with individualized educational plans (IEPs) and students who were classified as English Learners (ELs) were not centralized nodes in either classroom.

Network Density

The density of a network is measured by dividing the total number of ties that individuals report by the total number of possible ties (Daly, 2010). When many of the ties are realized, the network is described as dense and researchers can conclude that individuals interact a great deal. Like average degree centrality, mathematics classrooms consistently had higher density than their counterpart humanities classrooms. Table 16 displays the density of mathematics and humanities classrooms from focus teachers.

Table 16. Density of Student Networks

Density	Mathematics	Humanities	Years of Teaching Experience	Cycles of Lesson Study
Brielle's Class A	0.160	0.158	8	3
Brielle's Class B	0.105	0.084	8	3
Carlos' Class	0.129	0.106	10	10+
Mike's Class	0.103	0.093	19	1
Kesha's Class	0.102	0.078	8	7

Although data reveals that mathematics classrooms have higher densities of student networks than their counterpart humanities classrooms, teachers with more lesson study experience seem to have greater differences in density between their mathematics and humanities classes than their peers who have experienced fewer cycles of lesson study. Eighth grade classrooms in this sample also appear to generally have lower density scores in mathematics and humanities than 6th grade classroom density scores.

Dyad Reciprocity

Reciprocity is a reflection of the mutuality of ties between individuals. A relationship that is reciprocated between two students, indicates that they are connected to one another. When studying relationships between individuals, in which there is at least one identified outgoing or incoming tie, dyadic or dyad reciprocity is used to calculate what proportion of ties is symmetric or reciprocated (Borgatti et al., 2018). In this study, dyad reciprocity, as the previous social network measures, was calculated on Ucinet software (Borgatti et al., 2002). Table 17 shows the dyadic reciprocity in mathematics and humanities classes from four case study teachers' classrooms.

Table 17. Dyadic Reciprocity of Student Networks

Reciprocity	Mathematics	Humanities	Years of Teaching Experience	Cycles of Lesson Study
Brielle's Class A	0.118	0.144	8	3
Brielle's Class B	0.232	0.214	8	3
Carlos' Class	0.120	0.150	10	10+
Mike's Class	0.240	0.191	19	1
Kesha's Class	0.242	0.204	8	7

In the survey sample, the dyadic reciprocity of 8th grade math classrooms was higher than the dyadic reciprocity in 6th grade math classrooms. However, when comparing the dyadic reciprocity of mathematics to humanities classrooms, there were fewer consistent trends. Three out of five mathematics classrooms reported higher dyadic reciprocities than their humanities classrooms, while two mathematics classrooms reported lower dyadic reciprocities. The cycles of lesson study experienced by the teacher did not seem to be an influencing factor in the reported dyadic reciprocity of classrooms.

Summary of Findings

Qualitative and quantitative data describe how lesson study influences teachers' sense of efficacy around their ability to effectively engage students, manage classrooms, apply student-centered instruction, and manage student relationships. Quantitative teacher survey data, while not statistically significant, indicates a positive association between more lesson study experience and increased teacher sense of efficacy. Qualitative data from five focus teachers' semi-structured interviews explored how teachers experience lesson study and the structures that influence their sense of efficacy. From this data, four themes emerged; (1) fluctuations in teachers' sense of efficacy, (2) efficacy is influenced by Bandura's four

sources of information, (3) lesson study structures that support teacher efficacy, and (4) changes in teachers' sense of efficacy over time.

Additional quantitative data collected from student social network surveys suggests differences in the help-seeking networks of classrooms where lesson study approach was applied. Analysis of themes that emerged from the collected data provide insight into how lesson study approach can redefine teachers' sense of efficacy and the classroom communities they create.

CHAPTER FIVE: DISCUSSION

Overview of the Study

This study explored how and to what extent lesson study approach influenced math teachers' sense of efficacy and the help-seeking networks of students in the focus classrooms. In this study, teachers' sense of efficacy was conceptualized as a teachers' self-belief in their capability to effectively organize and execute the actions required to guide students to success (Ross, 1992). To determine how teacher sense of efficacy and the student help-seeking networks of their classrooms were impacted by lesson study approach, the following research questions were posed:

1. How and to what extent can lesson studies influence middle school math teachers' sense of efficacy around their ability to effectively:
    a. manage students?
    b. engage students?
    c. implement student-centered teaching strategies?
    d. manage peer relations?
2. What do the students' help-seeking networks look like in math classrooms in which lesson study approach is implemented?

To explore these questions, quantitative and qualitative data were collected including teacher sense of efficacy survey data, interviews from five focus teachers, and student social network data from four focus teacher classrooms. Quantitative teacher efficacy survey data from a nine point Likert scale was first analyzed with Qualtrics. Descriptive analysis was used to calculate the mean teacher efficacy scores in three categories; management, engagement, and instruction. Interview transcripts from five focus teachers were coded using the research

questions to uncover themes. Lastly, quantitative student survey data was collected electronically and analyzed to study the average degrees, density, and reciprocity of student help-seeking networks.

Discussion of Findings

This study yielded important findings about the influence of lesson study on teachers' sense of efficacy and the student help-seeking networks they create in their mathematics classrooms. The following section will discuss the affordances and challenges teachers experience using lesson study approach and how these findings relate to the identified areas of need for effective reform: (1) the need to foster teachers' sense of efficacy and (2) the need to develop connected student math communities.

Changes in Teacher Sense of Efficacy Through Lesson Study

Fluctuations and Trends in Teachers' Sense of Efficacy

From teacher survey data and focus teacher interviews, a range of teacher efficacy emerged. Since sense of efficacy is a multidimensional construct (Skaalvik & Bong, 2003) and can fluctuate as teachers experience setbacks, success, and failure, it is not surprising that this study found teachers describe frequent changes in their efficacy through lesson study (Bruce et al, 2010; Puchner & Taylor, 2006). Although fluctuations in teacher efficacy made it a difficult concept to capture, teacher efficacy increased with years of teaching experience and cycles of lesson study. This is aligned with research on lesson study that suggests teacher sense of efficacy and professional actions are reciprocal (Bruce et al, 2010; Puchner & Taylor, 2006).

Four Sources that Influence Teachers' Sense of Efficacy

In focus interviews, teachers discussed four sources of efficacy from lesson study which aligned with Bandura's (1986, 1997) proposed sources of information. While Bandura (1986, 1997) and focus teachers identified mastery experiences as most powerful for influencing teachers' efficacy, teachers participating in lesson study often take an active role through designing, observing, and analyzing the lesson (Lewis & Hurd, 2011). While all focus teachers had experienced lesson study both as the teacher leading the lesson and as a participant observing the lesson, focus teachers had fewer opportunities to lead the lesson and thus had fewer mastery experiences. Therefore, focus teachers often referenced lesson study's influence on their efficacy in relation to the vicarious experiences, social persuasion, and affective states they experienced.

Lesson Study's Influence on Increased Teacher Sense of Efficacy

This study found lesson study experiences increased teachers' general sense of efficacy. From teacher semi-structured interviews, all teachers valued lesson study and most reported increased levels of efficacy by participating in the professional learning approach. However, trends in teacher efficacy related to years of teaching experience emerged from teacher sense of efficacy data. This is aligned with findings that veteran teachers hold the highest general sense of efficacy, as well as the highest efficacy with regards to domain-specific areas such as student engagement and classroom management (Putnam, 2012). In their interviews, several focus teachers also referenced benefiting from lesson study most during their initial in-service years. Even though this may seem like a steep learning curve for novice teachers, research suggests sense of efficacy during a teachers' first few years in the classroom is dependent on the level of support received but also more malleable than veteran

teachers (Tschannen-Moran & Woolfolk Hoy, 2007). Thus, access to strong professional communities, such as those developed through lesson study, are especially critical for the capacity and retention of novice teachers (Bruce et al, 2010; Lewis et al, 2009; Lewis & Perry, 2017).

From semi-structured interviews, teachers reported that lesson study had "indirect" influences on their efficacy to manage peer relationships. Yet, student social networks of teachers with higher numbers of lesson study cycles experienced showed differences in the average degrees, density, and reciprocity of student help-seeking networks. While teachers did not see the purpose of lesson study as attending to student interactions, they did see lesson study as an opportunity to listen to, highlight, and leverage student thinking, particularly for marginalized students of color whose ideas may not normally be heard and valued without teacher support. This attention to elevating student ideas is likely to have a positive impact on how students' peers perceive their mathematical value, status, and working relationship (Horn, 2012).

Structures that Promote Teachers' Sense of Efficacy through Lesson Study

Data from teacher sense of efficacy surveys and focus teacher interviews suggests that lesson study plays a role in shaping teacher efficacy. Focus teachers identified three main structures of lesson study that influenced their efficacy to manage classrooms, engage students, and implement student-centered instruction.

Framing of Lesson Study

Teachers with varying experiences of lesson study cycles identified different purposes of the approach. In addition, teachers described a variety of lesson study models including but not limited to public lesson study, schoolwide lesson study, lesson study by groups of

specialists, teacher learning collaborative and voluntary lesson study (Lewis & Hurd, 2011). This contrast in framing lesson study revealed a variation in teacher efficacy and commitment to lesson study approach. While the findings between lesson study purpose and teacher sense of efficacy are new, misconceptions on the purpose of lesson study have been documented (Lewis & Hurd, 2011). Some common misconceptions of the purpose of lesson study include lesson study for lesson planning, producing a library of perfect lessons, and lesson study as a demonstration of expertise (Lewis & Hurd, 2011).

Push for Furthering Student-Centered Practices

Spending most of the time in isolated classrooms, focus teachers recognized that it was easy to fall back on what was comfortable. Lesson study encourages teachers to attempt skills and instructional routines beyond their current practices but still within their zone of proximal development. Vygotsky (1978) referred to the zone of proximal development (ZPD) as the range of abilities an individual can perform with assistance but not yet independently. These abilities are deemed "proximal" because the individual is approaching but not yet mastering the skill to be able to perform it without support, guidance, and practice (Vygotsky, 1978). The push to extend teacher practices, supported focus teachers in executing practices that they may not have attempted on their own. If the lesson was perceived as successful, it increased teachers' efficacy to effectively use the practice or at least continue trying to use it (Bandura, 1997; Bandura, 1986).

Situated Learning Context

Focus teacher interviews highlighted the classroom context as a key structure of lesson study that influenced teachers' efficacy. Unlike traditional professional development, lesson study unfolds in actual classrooms, in actual time and with actual students (Lewis & Hurd,

2011; Liptak, 2005). Within a lesson, a teacher makes hundreds of judgements instantly. Yet without a team of teachers collecting data, teachers are often left to their own devices and perceptions to make sense of their teaching. During a lesson study, colleagues record the teachers' and students' words, reactions, and behaviors--it is the analysis of this relevant data that fuels professional learning. (Lewis et. al, 2006; Lewis & Hurd, 2011).

Student Help-Seeking Networks in Lesson Study Classrooms

By being more attuned to the social and help-seeking networks of their students, teachers have the knowledge to disrupt patterns of inequitable status and hierarchy (Mamas et al, 2019). For example, seeing a visual map of his student networks compelled Mike into action. While he and other focus teachers did not directly attribute lesson study to influencing their efficacy to manage student relationships, he expressed that reviewing the social networks of his classroom forced him to attend to the dynamics of participation and isolation in his math classroom. After reviewing his students' social network maps, Mike shared that his perceptions of status and relationships did not always align to what students indicated in the survey. This realization encouraged Mike to consider how he could leverage skills and assets of his isolated students that would help their peers see them as valuable members to the classroom. Mike found value in studying his students' help-seeking networks and after the interview requested to have the social network survey be conducted with his current classroom of students. Teachers equipped with knowledge of student relationships and social interactions are likely to make more informed choices about student groupings and collaborative learning experiences (Gest & Rodkink, 2011; Gonzalez et al., 2005; Hamm et al., 2011; Mamas et al, 2019; Zambo, 2010).

Interview data from focus teachers did not identify lesson study as directly influencing their sense of efficacy around their ability to manage peer relationships. Yet differences in student help-seeking networks between teachers with more lesson study experience versus fewer lesson study experiences emerged. One notable difference between classroom networks of teachers who had more cycles of lesson study experience than teachers with fewer cycles of experience were the overall average degrees between students. Mathematics classrooms also had consistently higher values of average degree than their humanities classroom counterparts, regardless of the number of lesson studies experienced by the focus teacher. Similar to past research (Mamas et. al, in press), students in math classrooms who sent out more ties were less likely to ask for help and vice versa. This pattern was also observed in humanities classrooms but at lower rates since students sent fewer requests for help. A second notable difference was the demographic backgrounds of centrally positioned students in classroom networks of teachers who had more cycles of lesson study experience compared to teachers with fewer cycles of experience. Reviewing network maps, students clumped into pockets of similar demographics. Without intervention, students will naturally interact with peers who they believe share a similar sense of self, values, and identity (Gehlbach et al., 2016; Montoya, 2008). This is an opportunity for teachers to take intentional actions to help students recognize similarities between themselves and their peers, improve the social inclusion of isolated students, and disrupt present status hierarchies (Gest & Rodkin, 2011). In contrast to centrally positioned students, students with one to no ties in networks across case study classrooms were boys predominantly of Hispanic, African-American, or American Indian descent and qualified for free-reduced lunch. Additionally, students with individualized educational plans (IEPs) and students who were classified as English Learners

(ELs) were not centralized nodes in either classroom. These findings are similar to previous reciprocity findings that suggest that students with disabilities were more likely to form support ties with each other and less likely to seek and receive ties from general education students in the same classroom (Borgatti, 2018; Mamas et al., in press). Teachers should ensure all students have a chance to showcase their strengths to their peers and to contribute meaningfully to the group (González et al., 2005; Zambo, 2010). It is incumbent upon teachers to facilitate cooperative learning experiences that are structured to allow all members to participate and contribute (Zambo, 2010).

Implications of the Study

This study provided an opportunity to explore the impact of lesson study on middle school math teachers' sense of efficacy and the student help-seeking networks within their classrooms. In their interviews, teachers shared the successes and failures they experienced and how processing these experiences through lesson study influenced their efficacy. While many factors besides lesson study play a role in shaping teachers' efficacy, a strong sense of efficacy has been linked to teacher retention, teacher beliefs, teacher behaviors and ultimately desired student outcomes (Caprara et al, 2006; Goddard, Hoy & Woolfolk Hoy, 2004; Ross, 1998; Ross, 1992; Tschannen-Moran & Woolfolk Hoy, 2001). Findings from teacher interviews and survey results provide implications of the study which can be applied to practice, policy and theory, and future research.

Implications for Practice

This study has multiple implications for practice related to social justice issues. One of the most significant implications for practice is the link between teachers' sense of efficacy and traditionally marginalized students. Previous research has found teachers with a high

sense of efficacy hold the belief that with effort, they are able to support and teach the most challenging students, whereas teachers with low sense of efficacy are less likely to persist in supporting struggling learners (Ashton et al., 1993; Ross, 1995; Smylie, 1990). Investing in strengthening teacher efficacy has implications for the critical work that is done to support traditionally underserved learners and the messages teachers convey for this group of students.

This study also comes at a critical time during COVID-19 when students are physically isolated and struggling to maintain academic, social, and emotional connections. An additional implication for practice emerging in the study is the issue of dispersed and diverse student connections. While this study found differences in the student help-seeking networks of teachers who had participated in lesson study compared to networks of teachers with less lesson study experience, English language learners, students of color, and students with disabilities in both networks had lower participation status. This finding, along with previous research, implies that teachers should be making an active effort to facilitate and support student relationships (Gest & Rodkin, 2011; Mamas et al, 2019). These efforts have the potential to strengthen student connections for disadvantaged student populations and overall student networks.

By being more attuned to the social and help-seeking networks of their students, teachers have the knowledge to disrupt patterns of inequitable status and hierarchy. Focus teacher, Mike found value in visualizing the connections and social patterns that existed in his math classroom. This knowledge can be easily made available to teachers as data to inform their practices and decision-making. Access to software like UCINET that allows teachers to conduct descriptive analysis of social network data may provide teachers with a better

understanding of the student social structures in their classrooms (Borgatti et al., 2002; Mamas et al., 2019). Teachers equipped with this knowledge are likely to make more informed choices about student groupings and collaborative learning experiences.

Beyond awareness, teachers can take steps in the classroom to facilitate positive relationships between students and disrupt status hierarchies (Gest & Rodkin, 2011). This is particularly important at the transition to middle school when students place a higher priority on social relationships and belongingness. By using student-centered practices and focusing class discussions on sense-making, students will begin to recognize all students as mathematically brilliant and contributors to learning (Boaler, 1997; 2006; Gutierrez, 2000). Teachers play a critical role as social references to how students perceive their peers. If student A believes a teacher favors student B, it is likely that student A will also favor student B (Hendrickx et al., 2017). Visible positive teacher-student relationships model interactions and encourage other students to not only build relationships with marginalized students but strengthens the whole learning community (Hendrickx et al., 2017). Therefore, teachers should invest efforts in leveraging students' status and reinforcing student working relationships. These efforts can strengthen student academic connections and have the potential to spill over into students' friendship networks outside of the classroom (Gest & Rodkin, 2011; Mamas et al., 2019).

An additional implication for practice emerging from the study is the issue of a growing concern over the shortage of STEM (science, technology, engineering, and mathematics) teachers, secondary teachers, and teachers placed in lower socioeconomic schools, who quit the profession at higher rates and report lower efficacy scores than their colleagues (Garcia & Weiss, 2019; Sutcher et al., 2016). Student achievement in mathematics

suffers when there is a shortage of certified STEM teachers (National Commission on Teaching and America's Future, 2002). The National Commission on Teaching and America's Future (NCTAF, 2007) report about half of new STEM teachers leave the teaching profession within their first five years. This is a critical time for influencing the efficacy of novice teachers as they learn to become more confident in their classrooms. Research indicates that efficacious novice teachers report greater optimism for remaining in the teaching profession (Hall et al., 1992). Even veteran focus teachers, with 10+ years of teaching experience, cited in their interviews feelings of loneliness and self-doubt. An investment in boosting STEM teachers' efficacy, combined with access to support systems have been shown to have positive impacts not only on decreasing isolation but providing an avenue for teachers to learn together and ultimately increase their efficacy in impacting student learning (Bruce, et al. 2010; Cowley & Meehan, 2001). Thus, school leaders must turn their attention to the factors and school structures that support the development of a strong sense of efficacy.

Implications for Policy

Results of this study also have implications for policy. This study arises at a critical time in education that may have implications for the types and likelihood of teacher collaboration and school policy. The implementation of Common Core State Standards (National Governors Association, 2010) requires significant changes in mathematics instructional pedagogy, content knowledge, assessment, and curriculum. As teachers shift their pedagogical practices to align with new standards, they may likely question their efficacy in the classroom and seek resources and reassurance through peer networks. A better understanding of the structure and dimensions of teachers and students' social relationships can help to inform how to foster or constrain teacher efficacy and educational change.

Providing teachers with the support and opportunities to develop student-centered instruction requires an investment of time, funding, and resources in teachers' professional learning communities. These professional learning communities (PLCs) may include lesson study cycles, improvement science cycles, feedback to teaching teams provided by an instructional coach and simply creating the time and space for teachers to learn with and from one another. Past research suggests teachers with access to strong professional communities, such as those developed through lesson study, are more likely to change their instructional practices and increase student achievement, than their peers without access to these relationships (Lewis & Perry, 2017; Lewis et al, 2009). Yet, the structure of the school day often does not allow for teacher meetings to occur and leaves teachers to plan these meetings at the expense of their own time and resources. Policy should consider how intentional meeting times, resources and spaces for teachers can be structured throughout the school day to ensure that all teachers, regardless of personal and family obligations, can attend and benefit.

Implications for Theory

Social cognitive theory provides the overarching construct for this study and findings generally support this theoretical framework. Social cognitive theory posits that learning occurs within social contexts and considers the ways in which an individual's experiences factor into whether behavioral action will occur (Bandura, 1986). Teacher sense of efficacy is a construct that was developed within the context of Bandura's social cognitive theory. When teachers observe a colleague performing a behavior and its subsequent consequence through lesson study, they recall the sequence of these events as a guide for their own aligned behaviors. This sequence of thought was referenced throughout focus teacher interviews when discussing lesson study's impact on sense of efficacy.

Implications for Future Research

Extensive studies have been conducted on lesson study's relationship to teacher collaboration, teacher pedagogical knowledge, and student achievement (Fernandez & Yoshida, 2004; Lewis et al., 2009; Lewis et al., 2006; Lewis & Perry, 2017). Yet much less is known about the impact lesson study has on the student networks of teachers who have participated in lesson study. Although student academic achievement is a primary goal of instruction, social justice education should aim at considering the holistic growth of children. This includes, but is not limited to, their socio-emotional health, growth mindset, and sense of belongingness to the learning community. A students' connectedness to the learning community has critical implications for their identity, motivation and long-term academic achievement (Walton et al., 2012). As lesson study becomes more popular in the United States, there should be more empirical research on how lesson study can impact the belongingness and well-being of students.

Given that the data in this study was collected from an urban charter school district specializing in project-based learning, the findings have limited generalizability. Although my sample included 24 teachers and 5 focus teachers across 4 school sites, a larger and more diverse sample of teachers and schools would have allowed for a richer exploration of the study. Future studies may consider scaling the research to see if the findings of this study can be replicated. Control classrooms should also be included in future research to minimize the effects of variables other than lesson study experience.

Additionally, this study was limited to middle school mathematics teachers. Some of the challenges that face math classrooms are unique to the discipline of mathematics. While classroom communities founded on respect and inclusion are universal goals across grades

and disciplines, math teachers face additional challenges of perceived status and mathematical identity. Future research may explore the classroom connections of students in other disciplines such as humanities, science, and art. Better understanding the nuances of different networks of learners can provide insight to educators for improving their practices and structures of support.

This research regarding lesson study's impact on teacher sense of efficacy and student social networks utilized a mixed methods multiple case study convergent design. When applying a mixed methods case study design, I identified five teachers and their classrooms as focus cases. In considering my selection, I intentionally identified teachers to portray a diversity of lesson study experience, years of teaching experience, and racial backgrounds (Creswell & Plano Clark, 2018). All focus teachers were part of the organization's Mathematical Agency Improvement Community (MAIC) which promoted lesson study approach. Since lesson study is not mandated professional development (Doig & Groves, 2011), focus teachers with many cycles of lesson study experience were often invited by MAIC to continue participating in future lesson study opportunities because they valued the approach. The selection of focus teachers, mixed with quantitative data from teacher surveys, yielded an integrative description of the similarities and differences of each case. However, this selection may also have resulted in bias enthusiasm for lesson study. Inevitably, since not all cases could be studied, teachers with fewer cycles of lesson study are not prominently featured. Thus, the themes that emerge from these cases are unique and have limited transferability (Yin, 2017). Future research may consider using an alternative methodology such as mixed methods evaluation design to analyze lesson study as an intervention. This mixed methods design would allow long-term research with multiple objectives and a more

robust evaluation of lesson study's influence on teacher efficacy (Creswell & Plano Clark, 2018).

Limitations of the Study

Like all research, there are limitations in my study. The limitations of this study include that data is collected from a small, independent charter organization specializing in project-based learning. With a limited sample size of twenty-four teachers and five focus teachers working in a project-based learning environment, the data collected is not generalizable to a larger teaching population. Due to the collaborative nature and structure of the school, teachers interact daily in both professional and social settings. They conduct weekly staff meetings, collaborate on cross-curricular projects, share instructional resources, coordinate teaching schedules, and share working spaces such as teacher offices. Students also interact daily and travel as a cohort to various content classes. This allows for the same group of students to develop relationships over extended amounts of time and settings similar to elementary classrooms. This setting is unique to many large-scale, public middle schools and results may not be generalized. The data collected over a 9-month period is limited to a specific measurement in time and precludes any generalization about the potential long-term effects on teachers' sense of efficacy and student social networks. The results of this study are suggestive and not conclusive.

Additional limitations include the researcher's position as an instructional coach for some of the participating teachers and facilitator of lesson study cycles. With this, there is a risk of bias towards lesson study approach. At the same time, the researcher's position may have enabled participants to speak more openly and with more nuance about the role of lesson study related to efficacy. There may also be some focus teachers who felt free to express

sensitive issues regarding efficacy and their experience because the interviewer shared lesson study experiences. To mitigate this risk of bias, the triangulation of multiple data sources was employed.

Lastly, there may be a power imbalance between the interview participants and the researcher. In an attempt to equalize this power dynamic, trust was built with participants by encouraging them to speak honestly during interviews and regularly providing reassurance that all shared information would be used for research purposes only as outlined in the Institutional Review Board (IRB) application.

Conclusion

At a time when pressure to increase students' academic performance, particularly in math and science is intense, teacher efficacy is being negatively impacted by dwindling resources and increasing demands of external factors. Recent legislation (ESSA, 2015) requires a shift in teacher pedagogy to implement student-centered practices. With this transition, teachers may experience challenges resulting in lowered efficacy. Teacher efficacy is critical to reform and has been highlighted by research to have positive outcomes in student achievement, student efficacy, teacher instruction in the classroom and teacher motivation.

In sum, this study supports earlier findings on teacher efficacy but offers new insights into the influence of lesson study approach on teachers' sense of efficacy to engage students, implement student-centered instruction, manage classrooms, and manage student relationships. Using a mixed methods multiple case study design convergent approach, this study found that lesson study influenced teachers' sense of efficacy in three ways. Teachers reported four types of experiences from lesson study that influenced their efficacy, lesson study shifted the focus from teacher performance to student thinking, and an overall increased

efficacy that they could effectively engage students, utilize student-centered instruction and manage their classroom. Lesson study structures that supported teacher efficacy included sharing a student-centered focus, situating learning with a classroom context, and framing the lesson study. This study also presents a new awareness of help-seeking networks of students in diverse middle school mathematics classrooms. Although teachers did not identify direct links between lesson study and their efficacy to manage student relationships, notable differences in student help-seeking networks emerged. Although there are limitations on generalizability, the findings are especially useful to teachers. Understanding the mechanisms of relationship ties can help teachers attend more intentionally to social participation of students, particularly students of color, English language learners, and students with designated disabilities.

Creating student learning communities founded on collaboration and belongingness are important now more than ever. The recent onset of COVID-19 has left many students physically, emotionally, academically, and socially isolated. Yet this pandemic is not the sole cause of student isolation. Instead, it has revealed and exacerbated injustices that were already present in mathematics education. While this can paint a bleak picture of mathematics classrooms, interviews from focus teachers demonstrated the resilience, motivation, and efficacy of teachers to positively construct connected student communities. Lesson study approach demonstrates the collaborative potential of teachers to support their professional development while increasing their efficacy. It is my hope that the results of this study will be useful for educators interested in implementing lesson study as professional development for fostering teacher efficacy and building mathematics classrooms founded on respect, belongingness, and positive mathematical identities for all learners.

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Appendix A: Teacher Consent to Act as a Research Subject

UCSD IRB Project #190372SX

University of California, San Diego
Consent to Act as a Research Subject

Influence of Lesson Study on Teacher Self-Efficacy in Middle School Mathematics: A Mixed-Methods Case Study Design

Who is conducting the study, why you have been asked to participate, how you were selected, and what is the approximate number of participants in the study?
Kristin Komatsubara, a doctoral candidate from the Department of Education Studies at UCSD and CSUSM is conducting a research study to find out more about teachers' sense of efficacy they build through lesson study and its implications for classroom instruction. You have been asked to participate in this study because you are a mathematics classroom teacher. There will be approximately 30 teachers participating in this study.

Why is this study being done?
The purpose of this study is to find out more about teachers' beliefs influenced by lesson study in order to better support instruction, learning, and student relationships in the classroom.

What will happen to you in this study and which procedures are standard of care and which are experimental?
If you agree to be in this study, you can expect the following:
· You will take part in a 20-minute survey.
· You may be selected to participate in a 30 to 40-minute interview with the researcher about your views on lesson study and its possible impact on your teaching beliefs and instructional practices.

How much time will each study procedure take, what is your total time commitment, and how long will the study last?
The survey will take about 20 minutes to complete, and if you agree to participate in the interview, it may take 30-40 minutes. The study may be completed within a day or two.

What risks are associated with this study?
Participation in this study may involve some added risks or discomforts. These include the following:
1. Although small, there is a potential risk for the loss of confidentiality. All interview transcripts will be kept safely in a locked room. Computer-based data will be password-protected and encrypted. Research records will be kept confidential to the extent allowed by law. Research records may be reviewed by the UCSD Institutional Review Board.

2. Although small, there is a potential for boredom, fatigue, and emotional distress. Taking part in interviews can sometimes cause boredom and fatigue. All necessary precautions will be taken to avoid this. For example, interviews will be kept as short as possible. You may withdraw from the research at any point without any consequences and you can withdraw your data at any time. The confidentiality of your responses will be protected by encrypting computer-based data, such as your interview transcripts. The data will only be used for research purposes and not for evaluating your teaching practices or your views and opinions. During presentations of data or writing up of reports, your name and the school's name will never be disclosed.

Under California law, we must report information about known or reasonably suspected incidents of abuse or neglect of a child, dependent adult or elder including physical, sexual, emotional, and financial abuse or neglect. If any investigator has or is given such information, he or she may be required to report such information to the appropriate authorities.

Because this is a research study, there may also be some unknown risks that are currently unforeseeable. You will be informed of any significant new findings.

What are the alternatives to participating in this study?
The alternative to participation in this study is not participating.

What benefits can be reasonably expected?
There may or may not be any tangible benefit to you from participating this study. The investigator, however, may learn more about teacher efficacy and you can use that knowledge to inform your engagement in professional development such as lesson studies and your instruction practices.

Can you choose to not participate or withdraw from the study without penalty or loss of benefits?
Participation in research is entirely voluntary. You may refuse to participate or withdraw or refuse to answer specific questions in an interview or on a questionnaire at any time without penalty or loss of benefits to which you are entitled. If you decide that you no longer wish to continue in this study, you will be required to get in touch with the PI either by email at kkomatsubara@hightechhigh.org or phone 808-375-0228.

You will be told if any important new information is found during the course of this study that may affect your wanting to continue.

Can you be withdrawn from the study without your consent?
The PI may remove you from the study without your consent if the PI feels it is in your best interest or the best interest of the study. You may also be withdrawn from the study if you do not follow the instructions given you by the study personnel.

Will you be compensated for participating in this study?
There will be no financial compensation for participating in this research.

Are there any costs associated with participating in this study?
There will be no cost to you for participating in this study.

Who can you call if you have questions?
Kristin Komatsubara has explained this study to you and answered your questions. If you have other questions or research-related problems, you may reach Kristin at kkomatsubara@hightechhigh.org or 808-375-0228.

You may call the Human Research Protections Program Office at 858-246-HRPP (858-246-4777) to inquire about your rights as a research subject or to report research-related problems.

Your Signature and Consent
You have received a copy of this consent document.
You agree to participate.

_____
Teacher's Name

_____ _____
Subject's signature Date

UNIVERSITY OF CALIFORNIA, SAN DIEGO
AUDIO RECORDING RELEASE CONSENT FORM

Influence of Lesson Study on Teacher Self-Efficacy in Middle School Mathematics: A Mixed-Methods Case Study Design

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

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

2. The audio recording can be used for scientific publications. _____
   Initials

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

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

Teacher's Name: _____

_____ _____
Signature Date Witness
Date

Appendix B: Teachers' Sense of Efficacy Survey

Q1 Dear Teacher,

Please take a few minutes to complete the following survey about your teaching beliefs. Please be advised that there are no 'right' or 'wrong' answers to the questions. Your individual responses will remain confidential and anonymous. The research results will only be reported in summary form and will only be used for research purposes. Thank you in advance for your participation in this study.

Sincerely,
Kristin Komatsubara
University of California, San Diego

Q2 Please read the consent form here and download a copy for your records.
Teacher consent form

Q3 I confirm that I've read the consent form, downloaded a copy and:

- ○ I wish to participate in this survey (1)
- ○ I do not wish to participate in this survey (2)

Q4 What is your gender?

- ○ Female
- ○ Male
- ○ Other _____

Q5 What is your racial identity?

- ○ African American
- ○ Asian
- ○ Hispanic, Latinx
- ○ Native American
- ○ Pacific Islander
- ○ White
- ○ Other _____

Q6 How many years have you taught?

▼ 1 (1) ... 10+ years

Q7 Please list any teaching credentials you hold.

_____

Q8 What school do you teach at?

- ○ High Tech Middle
- ○ High Tech Middle Media Arts
- ○ High Tech Middle Chula Vista
- ○ High Tech Middle North County

Q9 What grade level(s) do you teach?

- ☐ 6
- ☐ 7
- ☐ 8

Q10 How many cycles of lesson study have your participated in? (not subject specific)

▼ 1 (1) ... 10+

Q11 **Directions:** Please indicate your opinion about each of the questions below by marking any one of the nine responses in the columns on the right side, ranging from (1) "None at all" to (9) "A Great Deal" as each represents a degree on the continuum.

Teacher Beliefs

This questionnaire is designed to help us gain a better understanding of the kinds of things that create challenges for teachers. Your answers are confidential.

Directions: Please indicate your opinion about each of the questions below by marking any one of the nine responses in the columns on the right side, ranging from (1) "None at all" to (9) "A Great Deal" as each represents a degree on the continuum.

Please respond to each of the questions by considering the combination of your *current* ability, resources, and opportunity to do each of the following in your present position.

	None at all		Very Little		Some Degree		Quite A Bit		A Great Deal
1. How much can you do to control disruptive behavior in the classroom?	1	2	3	4	5	6	7	8	9
2. How much can you do to motivate students who show low interest in school work?	1	2	3	4	5	6	7	8	9
3. How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5	6	7	8	9
4. How much can you do to help your students value learning?	1	2	3	4	5	6	7	8	9
5. To what extent can you craft good questions for your students?	1	2	3	4	5	6	7	8	9
6. How much can you do to get children to follow classroom rules?	1	2	3	4	5	6	7	8	9
7. How much can you do to get students to believe they can do well in school work?	1	2	3	4	5	6	7	8	9
8. How well can you establish a classroom management system with each group of students?	1	2	3	4	5	6	7	8	9
9. To what extent can you use a variety of assessment strategies?	1	2	3	4	5	6	7	8	9
10. To what extent can you provide an alternative explanation or example when students are confused?	1	2	3	4	5	6	7	8	9
11. How much can you assist families in helping their children do well in school?	1	2	3	4	5	6	7	8	9
12. How well can you implement alternative teaching strategies in your classroom?	1	2	3	4	5	6	7	8	9

(Tschannen Moran & Woolfolk Hoy, 2001)

Appendix C: Lesson Study Protocol
Facilitators Agenda
Mathematical Agency Improvement Community

Why Lesson Study?
In order to learn more about how our students learn mathematical concepts deeply, we need to spend time listening to their thinking in different contexts and in response to different instructional environments. Lesson study is a powerful way to do this with colleagues and provides a structure for us to engage in cycles of inquiry and reflection in order to learn and grow as professionals in our field.

Overview of Lesson Study Cycle:
Pre-brief (today): Lesson study teacher shares their mathematical goal for the lesson and their learning culture goal. Participants do the math together and anticipate student thinking. *(Note: in the future - this portion will be more extensive and lesson study teams will plan the lesson together. As our first round of lesson study events, the lesson study teacher and facilitator will do the bulk of that work this time.)*

Day of the lesson study: Briefly meet to confirm mathematical goal & learning culture goals. Lesson study teacher assigns each observing teacher a student or pair of students to focus on for the duration of the lesson.

Observe the lesson & collect data on student thinking: During the lesson the observing teachers are careful to abide by the norms of the lesson study:

- Respect the classroom atmosphere - silence phones and refrain from side conversations
- Arrive on time and stay for the entire lesson
- Resist the urge to help students or interfere with the natural flow of the lesson - be careful not to block students view of the board or the teacher
- Focus on how your assigned student is thinking about the mathematics - what do they say? What do they do? How do they react to the classroom routines/teacher moves/prompts?

Debrief: Block out an hour for the post-lesson debrief as soon as possible after the lesson. The lesson study teacher will have the opportunity to share first about how they felt the lesson went. This will be followed by an opportunity for participating teachers to share their observations of their focus student throughout the lesson. Following the teacher share out, participants engage in an open discussion around 1-2 key questions posed by the teacher. The lesson study teacher has the final word.

Protocol for Pre-Brief Day

5 min: Go over the rationale for lesson study and the overview of a lesson study cycle (above).

10 min: Do the math together and anticipate student thinking.

10 min: Share possible strategies and student sound bites you might hear if a students were solving this problem.

20 min: Lesson study teacher shares their anticipatory framework including: mathematical goal, learning culture goal, anticipated student thinking, potential sequence of student strategies/thinking for whole class discussion.

Mathematical Agency Improvement Community
Lesson Study Debrief Protocol
Facilitators Agenda

Norms For Participating in Lesson Study: During the lesson the observing teachers are careful to abide by the norms of the lesson study:

- **Respect the classroom atmosphere** - silence phones and refrain from side conversations
- **Arrive on time and stay for the entire lesson**
- **Resist the urge to help students or interfere with the natural flow of the lesson** - be careful not to block students view of the board or the teacher
- **Focus on how your assigned student is thinking about the mathematics** - what do they say? What do they do? How do they react to the classroom routines/teacher moves/prompts?

Debrief Protocol

Facilitator Frames the Debrief *(5 min)*
Teaching, by its very nature, is an act of vulnerability. Inviting others into our practice to observe can feel risky and destabilizing. However, these types of experiences also often lead to insight and growth for all participants. It is important as lesson study participants that we avoid making inferences and stay focused on observed student thinking. That way our questions and comments come from a place of curiosity and not a place of judgement.

Lesson Study Teacher Reflection *(10 min)*
The lesson study teacher shares what went well, what didn't, and any questions /wonderings on their mind that they would like the observers to discuss. *Facilitator takes note of specific questions/wonderings/themes the teacher would like the group to discuss.*

Observation Data *(10-15 min)*
Participants each have 1-2 minutes to share direct facts about their observed student(s). What did the student say or do? Which moments stand out as particularly important for

understanding how the student made sense of the mathematics? No questions are posed at this time. Participating teachers listen silently to the each other's observations.

Discussion *(25 min)*
The facilitator revisits and confirms the lesson study teacher's 1-2 questions/wonderings for the following discussion. The lesson study teacher steps out of the circle of conversation to listen/takes notes while the observing teachers discuss the question/wondering in light of the student observation data.

Lesson Study Teacher Takeaways/Next Steps *(10 min)*
The lesson study teacher rejoins the group and shares his/her take-aways. They do not need to respond to any particular comment from the discussion, instead this is a space for the lesson study teacher to reflect on learnings and possible next steps.

(Mathematical Agency Improvement Community, 2018)

Appendix D: Teacher Efficacy Interview Questions

UCSD IRB Project #190372SX

1. How would you describe lesson study to someone who hasn't heard of the practice?

2. What has been your experience(s) with lesson study?
    a. What are some of the benefits of lesson study?
        Can you tell me a little more about how it helps you x?
    b. What are some of the challenges of lesson study?
    c. Has lesson study had any influence on your thinking about instruction/management/expectations for student learning in the classroom?

In the past few years, our organization has shifted their math vision to create student-centred and discourse-based learning environments.

3. How well do you feel prepared to teach math this way?
    a. Tell me about some of the challenges/successes you experienced.
    b. How did these experiences influence your thinking about instruction/management/expectations for student learning?
    c. Do you feel lesson study has any impact on your thinking or preparedness to teach math this way?

In our schools, math is taught in untracked classrooms requiring teachers to serve a diverse range of learners.

4. How well do you feel prepared to support the unique needs of different learners?
    a. Tell me about some of the challenges/benefits of supporting a range of learners.
    b. How did these experiences influence your thinking about instruction/management/expectations for student learning?
    c. Do you feel lesson study has any impact on your thinking or preparedness to teach math to a diverse group of learners?

Middle school can be a time where peer friendships and social relationships play an increasingly important role in students' lives.

5. How well do you feel prepared to help students navigate these social relationships in class?
    a. Tell me about some of the challenges/successes you experienced.
    b. How did these experiences influence your thinking about instruction/management/expectations for student learning?
    c. Do you feel that lesson study has any impact on student relationships? Tell me about that.

6. In what way does lesson study influence how you interact or collaborate with your colleagues?

a. Tell me about that.
b. Can you give me an example of _____?
c. Are there any other colleagues you go to for support?

Appendix E: Parent Consent for Child to Act as a Research Subject

UCSD IRB Project #190372SX

University of California, San Diego
Parent Consent for Child to Act as a Research Subject

Influence of Lesson Study on Teacher Self-Efficacy in Middle School Mathematics: A Mixed-Methods Case Study Design

Who is conducting the study, why your child has been asked to participate, how your child was selected, and what is the approximate number of participants in the study?
Kristin Komatsubara, a doctoral candidate from the Department of Education Studies at UCSD and CSUSM is conducting a research study to find out more about the social networks of children in schools. Your child has been selected randomly to participate because s/he attends a middle school in either San Diego Unified School District or State Benefit Charter High Tech High. There will be approximately 200 student participants in this study.

Why is this study being done?
The purpose of this study is to find out more about the social relationships of middle school students in relation to their teachers' confidence and teaching practices.

What will happen to your child in this study and which procedures are standard of care and which are experimental?
If you agree to allow your child to be in this study, your child will be asked to:
· Complete a short survey (about 15 minutes) at the beginning of the project about their friendships and social interactions at school.

How much time will each study procedure take, what is your child's total time commitment, and how long will the study last?
The survey will take about 15 minutes to complete.

What risks are associated with this study?
Participation in this study may involve some added risks or discomforts. These include the following:
1. Although small, there is a potential risk for the loss of confidentiality. While every effort will be made to reduce this risk, there is a small possibility of a loss of confidentiality in this study. In order to minimize this risk, research records will be kept confidential to the extent allowed by the law. Research records may be reviewed by the UCSD Institutional Review Board. All computer-based survey data will be password-protected and encrypted. Your child's name will be replaced by a number. During the presentations of data or writing up of reports, the names of the children and school will never be disclosed.
2. Although small, additional risks may include boredom, fatigue, sadness or discomfort. Completing a survey can sometimes cause boredom and fatigue. All necessary precautions will be taken to avoid this. The survey is kept as short and simple as possible. Your children

may withdraw from the research at any point without any consequences and you can withdraw their data at any time. For children who may become sad or perhaps a child who has been previously bullied, school resources such as access to a counselor will be provided. The confidentiality of your child's response will be protected as described above and the data will only be used for research purposes.

Under California law, we must report information about known or reasonably suspected incidents of abuse or neglect of a child including physical, sexual, emotional, and financial abuse or neglect. If any investigator has or is given such information, he or she may be required to report such information to the appropriate authorities.

Because this is a research study, there may also be some unknown risks that are currently unforeseeable. You will be informed of any significant new findings.

What are the alternatives to participating in this study?
The alternative to participation in this study is not participating.

What benefits can be reasonably expected?
There are no direct benefits to your child from participating in this study. The investigator, however, may learn more about student social networks and teachers' confidence, which will be shared with your child's teacher to help improve instruction and learning in the classroom.

Can you choose to not to have your child participate or withdraw from the study without penalty or loss of benefits?
Participation in research is entirely voluntary. You may refuse to allow your child to participate or withdraw your child or refuse to allow your child to answer specific questions in the survey at any time without penalty or loss of benefits to which you or your child are entitled. This research is not part of your child's regular school program and is not being conducted under the auspices of the school. Your child's grade or continued enrollment will not be affected by her/his decision to participate. If you no longer wish your child to continue in this study, your child will be required to participate in other activities with the classroom teachers while the investigator is distributing the survey to the rest of the children.

You will be told if any important new information is found during the course of this study that may affect your child wanting to continue.

Can your child be withdrawn from the study without your consent?
The PI may remove your child from the study without your consent if the PI feels it is in your child's best interest or the best interest of the study. Your child may also be withdrawn from the study if you or your child do not follow the instructions given to you or your child by the study personnel.

Will you be compensated for participating in this study?
There will be no compensation for you or your child for participating in this research.

Are there any costs associated with participating in this study?
There will be no cost to you or your child for participating in this study.

Who can you call if you have questions?
Kristin Komatsubara has explained this study to you and answered your questions. If you have other questions or research-related problems, you may reach Kristin Komatsubara at kkomatsubara@hightechhigh.org or 808-375-0228.

You may call the Human Research Protections Program Office at 858-246-HRPP (858-246-4777) to inquire about your rights as a research subject or to report research-related problems.

Your Signature and Consent

You have received a copy of this consent document.

You agree to allow your child to participate.

_____ _____

Parent/Guardian signature Date

Appendix F: Assent to Act as a Research Subject (Ages 13-17)

UCSD IRB Project #190372SX

University of California, San Diego
Assent to Act as a Research Subject
(Ages 13-17 years)

Influence of Lesson Study on Teacher Self-Efficacy in Middle School Mathematics: A Mixed-Methods Case Study Design

Who is conducting the study, why you have been asked to participate, how you were selected, and what is the approximate number of participants in the study?
Kristin Komatsubara, a doctoral candidate from the Department of Education Studies at UCSD and CSUSM is conducting a research study to find out more about your friends at school. You have been asked to participate in this study because we want to find out more about how kids get along with others in your school. There will be approximately 200 participants in this study.

Why is this study being done?
The purpose of this study is to find out more about the social relationships of middle school students in relation to their teachers' confidence and teaching practices.

If you agree to be in this study, you will be asked to:
· Complete a short survey (about 15 minutes) about your friendships and social interactions at school.

How much time will each study procedure take, what is your total time commitment, and how long will the study last?
The survey will take about 15 minutes to complete.

What risks are associated with this study?
Participation in this study may involve some added risks or discomforts. These include the following:
1. Although small, there is a potential risk for the loss of confidentiality. Every effort will be made to reduce this risk and research records will be kept confidential to the extent allowed by the law. Research records may be reviewed by the UCSD Institutional Review Board. All computer-based survey data will be password-protected and encrypted. Your name will be replaced by a number. During the presentations of data or writing up of reports, your name and the school's name will never be disclosed.
2. Although small, additional risks may include boredom, fatigue, sadness or discomfort. Completing a survey can sometimes cause boredom and fatigue. All necessary precautions will be taken to avoid this. The survey is kept as short and simple as possible. If you become sad, you can talk with a trusted adult or school counselor. You may withdraw from the

research at any point without any consequences. Your confidentiality will be protected as described above and the data will only be used for research purposes.

We will not tell anyone what you tell us without your permission unless there is something that could be dangerous to you or someone else. If you tell us that someone is or has been hurting you, we have to tell that to people who are responsible for protecting children so they can make sure you are safe.

Because this is a research study, there may also be some unknown risks that are currently unforeseeable. You will be informed of any significant new findings.

What are the alternatives to participating in this study?
The alternative to participation in this study is not participating.

What benefits can be reasonably expected?
There are no direct benefits from participating in this study. The investigator, however, may learn more about student relationships and teachers' confidence, which will be shared with your teacher to help improve instruction and learning in your classroom.

Can you choose to not participate or withdraw from the study without penalty or loss of benefits?
Participation in research is entirely voluntary. You may refuse to participate or withdraw or refuse to answer specific questions on a survey at any time without penalty or loss of benefits to which you are entitled. This research is not part of your regular school program and your decision to participate or not participate will have no impact on your grade or enrollment in the school. If you decide that you no longer wish to continue in this study, you will be required to participate in other activities with the classroom teachers while the investigator is distributing the survey to the rest of the children.

You will be told if any important new information is found during the course of this study that may affect you wanting to continue.

Can you be withdrawn from the study without your assent?
The PI may remove you from the study without your consent if the PI feels it is in your best interest or the best interest of the study. You may also be withdrawn from the study if you do not follow the instructions given you by the study personnel.

Will you be compensated for participating in this study?
There will be no compensation for you or your child for participating in this research.

Who can you call if you have questions?
Kristin Komatsubara has explained this study to you and answered your questions. If you have other questions or research-related problems, you may reach Kristin Komatsubara at kkomatsubara@hightechhigh.org or 808-375-0228.

You may call the Human Research Protections Program Office at 858-246-HRPP (858-246-4777) to inquire about your rights as a research subject or to report research-related problems.

Your Signature and Assent

You have received a copy of this assent document.

You agree to participate.

_____ _____

Subject's signature Date

Appendix G: Assent to Act as a Research Subject (Ages 7-12 years)

UCSD IRB Project #190372SX

University of California, San Diego
Assent to Act as a Research Subject
(Ages 7-12 years)

Friendship Study

Kristin Komatsubara is doing a research study to find out more about how teachers can help students form friendships at school. You are being asked if you want to be in this study because we want to find out more about how kids get along with others in your school.

If you decide you want to be in this research study, I will ask you to answer some questions in a short survey that will take about 15 minutes. Filling out the survey is entirely up to you.

Sometimes kids don't feel good while being in a study. I will do my best for this study to be interesting and brief. If you get tired or don't feel good about being in the study for any reason during the survey, be sure to tell Kristin, your teacher or whoever takes care of you at home (mom, dad, grandparents, or whoever is in charge of you at home).

You don't have to be in this research study if you don't want to. Nobody will be mad at you if you say no. Even if you say yes now and change your mind after you start doing this study, you can stop and no one will be mad. It is very important to know that your answers won't be share with your friends.

Be sure to ask Kristin to tell you more about anything you don't understand.

Yes, you will be in this research study. No, you don't want to do this.

_____ _____
Write your name on this line Date

Signature Of Person Obtaining Assent

In my judgment, the participant is voluntarily and knowingly giving assent and possesses the legal capacity to give assent to participate in the study.

_____ _____

Signature of person obtaining assent Date

Appendix H: Student Social Network Survey

UCSD IRB Project #190372SX

Your name: _____ Date: _____

Please, check the names of as many classmates in the list below that are **your close friends**.

	1.
	2.
	3.
	4.

In Math Class, who do you ask **for help** if your teacher is not available?
Check as many classmates in the list below.

	1.
	2.
	3.
	4.

In Humanities Class, who do you ask **for help** if your teacher is not available?
Check as many classmates in the list below.

	1.

	2.
	3.
	4.

Thank you very much!