MATHEMATICS TEACHER MOTIVATION IN THE CONTEXT OF

LESSON STUDY WITH OPEN APPROACH

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Providing professional development to in-service teachers remains a high priority when attempting to meet state and federal school accountability requirements, yet principals may neglect teacher motivation and the teacher change process when facilitating teacher learning. Drawing on self-determination theory, this research examined social and environmental factors shaping teacher motivation in the context of lesson study with open approach. This descriptive case study included the perceptions of eight secondary mathematics teachers who engaged lesson study as a form of professional development. Thematic analysis of semi-structured interviews suggested the following contextual factors improve motivation: emerging proficiency, synergy, interpersonal dynamics, volition, and internalization. Additionally, apprehension, minor barriers, and contentious interpersonal dynamics may reduce intrinsic-like motivation. As teachers encountered supportive contextual factors, they satisfied their need to experience competence, relatedness, and autonomy which encouraged value internalization of new learning manifesting as an epistemological shift in teaching paradigm. By internalizing the value of new learning, teachers may become more likely to authentically enact new pedagogy in their classrooms. The results of this study indicated lesson study with open approach may provide a robust form of learning capable of changing prior instructional beliefs. These findings suggest principals create and maintain contextual factors (with deliberate intent) that promote intrinsic-like motivation and the teacher change process to enhance the healthy development of teacher learning.

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CHAPTER 1

INTRODUCTION

Although public school principals manage countless responsibilities; arguably, their most important role converges on instructional leadership. This critical role guides the impact and quality of teacher learning and student achievement, which facilitates desirable outcomes in today's accountability culture (Honig, 2012). To illustrate instructional leadership qualities, Blasé and Blasé (1999) suggested effective principals promote teacher learning through professional development (PD) by: (a) providing multiple PD opportunities, (b) encouraging collaboration, (c) promoting coaching (or mentoring relationships among staff), (d) allowing PD modifications to meet teachers' needs, and (e) applying adult learning theory to PD. To further support the impact of instructional leadership, Marzano, Waters, and McNulty (2005) quantitatively determined, via meta-analysis, that a school principal positively impacts student achievement through effectual instructional leadership actions.

Even though Marzano et al. (2005) reported a positive correlation between instructional leadership skills and student achievement, many principals have not received adequate support to develop these skills (Honig, 2012). As a result, many principals lack deep pedagogical understanding because university preparation programs do not require them to take courses highlighting in-depth curricular studies (Lemoine, McCormack, & Richardson, 2014). Additionally, Honig (2012) reminds us that instructional support from district-level personnel remains unlikely or random at best. For example, Honig (2012) emphasizes, "central offices were originally established and have historically operated to carry out a limited range of largely regulatory and basic business functions—not to support teaching and learning improvement, let alone provide intensive support for principals' instructional leadership" (p. 735). As a result,

researchers may consider producing information to support principals by investigating and reporting findings that offer practical information to guide PD and instructional decisions.

Research Problem

Within the last five decades, public perception and legislative mandates (i.e., federal and state laws and guidelines) have encouraged public school reform movements in the United States (U.S.; Spring, 2014). This phenomenon continues today under the guise of neoliberalism (Lipman, 2011), which shifts the focus of reforms away from citizenship towards global economic competitiveness (Pinar, Reynolds, Slattery, & Taubman, 1995). In many cases, accountability mandates (i.e., overwhelmingly supported by the public and policymakers; Cizek, 2001) are made manifest through the implementation of high-stakes testing. Therefore, the need to improve student achievement has increased in recent years, given today's testing and punishment-laden accountability systems (Kim, 2018). For example, the Every Student Succeeds Act (2015) rewards schools that meet federal and state standards and punishes those who do not meet expectations (Schniedwind & Tanis, 2017).

Regardless of one's stance on the ability of a single standardized assessment to accurately measure a student's knowledge, the results of this test ultimately determine a school's success or failure in the eyes of the state and the public (Carnoy & Leob, 2002; Popham, 1999). Because of these increased accountability measures, administrators and school districts continuously search for ways to increase student achievement. Because of this pressure, many schools turn to in-service teacher PD to support student achievement by educating their current faculty (Gusky, 2002; Little, 2005). To illustrate, providing high-quality PD describes the main initiative public school administrators employ to meet this growing pressure due to studies that suggest increasing the quality of teaching translates to higher levels of student achievement (Carpenter,

Fennema, Peterson, Chiang, & Leof, 1989; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Gallucci, DeVoogt, Yoon, & Boatright, 2010).

Because of this pressure to improve schools, public school administrators and stakeholders select and implement PD approaches that effectively improve teaching practices and fall within the school's capacity to provide (a) curricular, (b) financial, (d) technical, and (d) cultural capital (Cornman, 2015; Shulman & Shulman, 2004). This compels administrators to select the best PD approach for their school while meeting budget and personnel capacities. Additionally, administrators may consider how each PD approach influences specific content areas, such as electives, liberal arts, and mathematics.

Mathematics Professional Development.

Although administrators may feel wide-ranging pressure to improve student achievement across disciplines, policymakers have specifically focused on mathematics instruction (Borasi & Fonzi, 2002). This reform-minded focus drives PD decisions related to improving mathematics pedagogy. For example, the National Council of Teachers of Mathematics (NCTM) released mathematics standards in 1989 (and then revised the standards in 2000) designed to promote (a) constructivist, (b) inquiry-based, and (c) conceptual instructional approaches (Clark, 1994). One aspect of these standards promoted the use of constructivist approaches, guiding teachers to facilitate active student participation by helping students create their own ideas or understanding of mathematical principles and formulas. The standards included guiding students to (a) experiment, (b) challenge, (c) question, (d) reflect, (e) invent, or (f) discover their own meaning and, under the teacher's guidance, apply their newly constructed conceptual understandings to real-world mathematics problems. The new standards stood in contrast to traditional approaches of mathematics instruction, which included (a) taking notes,

(b) memorizing problem-solving steps, and (c) completing homework. Moreover, this initiative continued in 2010 with the release of the Common Core State Standards in Mathematics (CCSSM), which stressed the use of constructivist teaching approaches (Borasi & Fonzi, 2002).

The first major study designed to evaluate teacher enactment of these constructivist instructional techniques reported poor progress. Stigler and Hiebert (1999) analyzed videos from the 1999 Third International Mathematics and Science Study (TIMSS) and determined eighth-grade mathematics teachers across the U.S. did not implement the NCTM standards as envisioned. When compared to other countries, American teachers neglected the use of application problems, which negatively impacted students because these problems promoted the demonstration of conceptual understanding. In contrast, American teachers prioritized exercise-type problems, which promoted the use of memorized procedural steps. According to Hiebert et al. (2005), "virtually none of the making connections problems in the US were discussed in a way that made the mathematical connections or relationships visible for students" (p. 120). In sum, American mathematics teachers delivered unchallenging and fragmented curriculum based on a procedural approach.

A more recent example of failing to enact standards involved the implementation of the CCSSM when Olson, Olson, and Capen (2014) examined how mathematics teachers enacted the CCSSM. According to their study, 60% of the mathematics teachers operationalized the standards by converting them into traditional instructional approaches. In other words, the teachers interpreted the standards through the lens of traditional teaching, thus compromising the intent of using constructivist approaches. By using a traditional lens, teachers enacted the standards from a teacher-centric perspective as opposed to a constructivist perspective. Hiebert et al., (2005) and Olson et al., (2014) revealed two facts: (a) teachers, as a whole, maintained a

traditional method of mathematics instruction and (b) teaching conceptually challenged teachers, especially if they had experience. These studies suggested PD aimed at helping mathematics teachers should be robust in order to change how teachers create instruction based on their previous beliefs and instructional paradigms. Although challenging, the PD method of lesson study with open approach (LSOA) demonstrates a promising tool to meet this challenge.

Lesson Study with Open Approach

While mathematics teachers in the U.S. struggled to teach conceptually based on progressive standards, the same situation occurred for mathematics teachers in Thailand. With striking similarity, Inprasitha, Pattanajak, and Inprasitha (2012) reported the Thai Ministry of Education published new mathematics standards in 1999 to inspire teaching approaches emphasizing constructivist methods of instruction. After evaluating the 1999 TIMSS results and 2003/2006 Program for International Student Assessment results, the authors concluded that Thai teachers persistently taught mathematics from a traditional approach, which emphasized the use of lectures to teach procedural steps to solve problems. In other words, the teachers did not emphasize the students' ability to solve problems on their own. In fact, many teachers reinforced the perception that solving a problem required one strategy versus the possibility of using multiple strategies to solve the same problem. Teachers did not create or allow space for students to discover their own problem-solving strategies. Because of this persistent condition, researchers in Thailand studied how to facilitate an environment of teacher learning that could effectively change teacher-engrained patterns of behavior and thinking (i.e., their instructional paradigm). As a result, M. Inprasitha operationalized an approach to PD called LSOA by promoting its use in public schools (Kongthip, Inprasitha, Pattanajak, & Inprasitha, 2012).

The concept of LSOA builds from the confluence of the PD approach termed *lesson study* and the teaching lesson cycle known as *open approach*. Lesson study describes a professional learning tool developed in Japan over 140 years ago (Isoda, 2015). Lesson study considers teachers as researchers and provides them with classroom-based support systems centered on coherent, sustained, and focused collective learning opportunities. The three phases of the lesson study cycle include (1) collaborative lesson planning, (2) observing a live teaching demonstration, and (3) finishing with a collective teacher debriefing (Isoda, 2015).

Using the lesson study cycle, teachers begin their research process by collectively determining an instructional area in need of improvement (content focus). Once the teachers determine a topic or focus, they work together (collective participation) to develop a model lesson designed to address the targeted area (active learning). One of the teachers then teaches the lesson in a live classroom while the other teachers observe (coherence) and collect information. Of notable importance, the observers focus on collecting data related to student thinking about the lesson and how students interpret the lesson; the teachers acting as observers do not evaluate the performance of the teacher. After the live lesson, teachers meet and reflect on the effectiveness of the learning (Murata, 2011). This continuous cycle of improvement further enhances the effectiveness of lessons and student learning.

In Thailand, M. Inprasitha enhanced this cycle of continuous improvement by operationalizing the concept of open approach in the mathematics classroom (Kongthip et al., 2012). To clarify the open approach lesson cycle, teachers execute the following four steps: (1) pose an open-ended problem, (2) provide time for student self-learning, (3) facilitate whole class discussion, and (4) summarize and make connections (Suriyon, Inprasitha, & Sangaroon, 2013). To illustrate, the teacher introduces an open-ended problem to the class designed to elicit

multiple solutions. The second phase provides time for students to explore the problem, and the third phase allows students to describe their understanding of mathematic concepts in their own words. The last phase allows the teacher to make connections between student thinking and clarifies student understanding in relation to mathematics principles (Chaona & Inprasitha, 2013).

M. Inprasitha (2015) incorporated the open approach lesson model into the cycle of lesson study, thus creating the concept termed LSOA. Thai teachers involved in this process follow the traditional steps of lesson study; however, during their live classroom lessons, they follow the phases of open approach. Taken together, LSOA has demonstrated promising results related to increasing teacher and student learning (Kongthip et al., 2012). Studies have determined that teachers can experience substantial behavioral changes in the classroom after participating in LSOA learning cycles. In other words, teachers have successfully shifted away from how they teach. After participating in LSOA, teachers moved away from traditional approaches and consistently used a constructivist, inquiry-based form of instruction, fostering their students' understanding mathematics from a conceptual perspective (Changsri, Inprasitha, Pattanajak, & Changtong, 2012; Chaovasetthakul, Inprasitha, & Changsri, 2017; Inprasitha, 2014; Inprasitha & Changsri, 2014; Jai-on & Inprasitha, 2017; Jai-on, Inprasitha, Saengarun, & Srichompoo, 2017). LSOA has the capacity to realistically guide teachers through the change process which has proven to be fundamentally challenging. Although LSOA has demonstrated promising results, researchers have not addressed motivational factors that affect participating teachers.

Teacher Motivation

When discussing teacher PD, Shulman and Shulman (2004) asked, "Are there stages,

levels, or categories of motivation, commitment, or disposition?" (p. 261). Moreover, they

inquired if environmental factors can mitigate motivation as well as, "Where does the will to

change come from?" (p. 261). Lastly, they posed, "To what extent is 'willing' an internal

category, and to what extent is it the result of the management of external incentives, rewards,

and pressures?" (p. 261). These questions, as they relate to a teacher's motivation to participate

in PD, represent impactful concepts because motivation can influence a teacher's level of

commitment and dedication to new learning (Gorozidis & Papaioannou, 2014; Guskey, 2000;

Ryan & Deci, 2000). To support this point, Guskey (2002) has suggested PD initiatives often fail

because they do not attend to teacher motivation or the teacher change process. He purports that

deliberate attention to motivational factors can help teachers learn and change their beliefs about

the effectiveness of new instructional practices.

In reference to teacher motivation, *self-determination theory* (SDT) answers the

impactful questions purposed by Shulman and Shulman (2004). For example, they asked about

(a) stages of motivation, (b) environmental factors, and (c) internal/external will. Succinctly,

SDT answers their questions by emphasizing the existence of motivation stages, mediated by

environmental factors, which fall across a continuum based on external and internal will. Ryan

and Deci (2000) claim individuals become more motivated to complete a task when they

perceive their own willingness to act as their primary source of incentive. In other words, people

obtain more enjoyment/satisfaction when they act according to their own free will. Deci and

Ryan (1985) remind us this level of motivation (autonomous) underlies the foundation of

intrinsic drive. In contrast, the opposite end of the continuum reflects low motivation, which

occurs when individuals perceive their actions are influenced or caused by external sources of

authority. People gain less enjoyment/satisfaction when they feel forced to complete a task. This

level of motivation (controlling) diminishes drive due to the individual's perception of an external force controlling their actions. Additionally, Deci and Ryan (2008) claim environmental and social factors mediate both autonomous and controlled motivation.

Chatzisarantis and Hagger (2009) addressed motivation when they argued environmental factors surrounding teachers greatly influenced their motivational style. They suggested individuals acting in autonomous environments naturally tended to adopt autonomous motivation styles of behavior in contrast to individuals acting in controlling environments. Hence, people operating in controlling environments tended to adopt and use controlling motivational styles. This finding suggests teachers operating in controlling environments, such as pressure to obtain high standardized assessment scores, adopt and use similarly controlling behaviors in the classroom with their students and this behavior leads to lower forms of motivation (Pelletier, Seguin-Levesque, & Legault, 2002).

When examining teacher motivation to participate in PD, Gorozidis and Papaioannou (2014) examined how primary mathematics teachers in Cyprus reacted to the implementation of inquiry-based approaches to instruction. Their results indicated that teachers with high autonomous motivation more willingly accepted higher workloads when compared to teachers who did not demonstrate autonomous motivation. In other words, teachers who believed they could adjust the new curriculum to meet the needs of their specific students expressed higher levels of autonomous motivation because they perceived this ability as governing their own choices. Autonomous motivation increased when teachers had the ability to provide input into how administrators conducted the PD. Conversely, teachers who felt they had no ability to make choices or provide input expressed lower levels of motivation because they felt they were being controlled.

Gorozidis and Papaioannou (2014) also suggested the use of extrinsic motivators, such as teacher evaluations to promote a new initiative, produced perceptions of control leading to superficial implementation over a short time period. They stated, "It seems that teachers' autonomous motivation in every aspect of their work (i.e., in-service training) is a vital ingredient for their optimal functioning and professional growth" (Gorozidis & Papaioannou ,2014, p. 3). In sum, Gorozidis and Papaioannou reinforced Guskey's (2002) claim that attending to the motivational needs of teachers underpins a strong foundation for successful PD implementation.

Although attending to teacher autonomous motivation during PD reinforces a key component, many researchers and practitioners often neglect this important dimension. Hargreaves (2005) argued policymakers and staff developers often ignore teacher motivation when creating reform legislation. He asserted teachers developed commitment to new learning initiatives when they became emotionally invested. Additionally, Korthagen (2017) stated that administrators should focus on what teachers need because "a teacher's ideals are an important driving force in their teaching" (p. 390). Korthagen advanced the idea that motivation represented the missing piece when school officials chose and enacted PD approaches; hence, more attention and research should focus on the motivational dimension of teacher PD. Studies examining teacher motivation within the context of PD should consider the use of a theoretical framework capable of providing theory to describe and define the relationship between PD contextual factors and teacher reactions in terms of specific motivational behaviors.

Theoretical Framework

SDT serves as a theoretical framework for organizing and situating motivation in relation to PD contextual factors. According to Deci and Ryan (2008), intrinsic motivation occurs when

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individuals exhibit high levels of three basic psychological needs. These needs include

(a) competence, (b) autonomy, and (c) relatedness. *Competence* describes feeling able to

complete a task with confidence and reassurance, while *autonomy* expresses feeling in control of

a situation and exhibiting free choice. *Relatedness* describes feeling valued and experiencing

inclusion in a safe and reassuring group. Taken together, these three psychological needs when

properly sustained, facilitate elevated levels of autonomous motivation.

Additionally, Ryan and Deci (2000) proposed a continuum of motivation ranging from

amotivation, a complete lack of will to accomplish a task, to *intrinsic motivation*, engaging in a

task for pure enjoyment (see Figure 1). Different levels of extrinsic motivation occupy the center

of the continuum, which consists of (a) external, (b) introjected, (c) identified, and (d) integrated

motivations. Externally motivated individuals complete tasks as a result of reinforcements and

punishments, while intrinsically motivated individuals complete tasks because of their perceived

value.
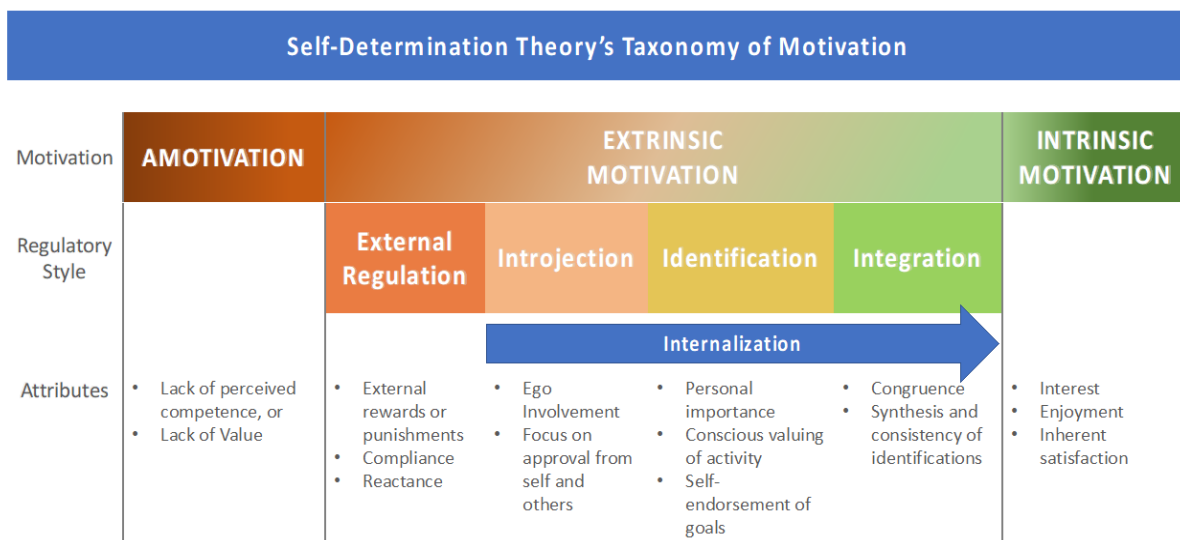
Figure 1. Self-determination theory's taxonomy of motivation (Ryan & Deci, 2017).

Ryan and Deci (2017) have suggested that if a person starts to experience the three

psychological needs, they can move to the right side of the continuum, thus becoming more

intrinsically motivated. To illustrate, teachers who begin a PD program due to pressure from

administration may experience external motivation if they comply in order to avoid a punishment. However, if teachers begin to see value in their learning, they can move laterally to higher forms of intrinsic-like motivation. In the process, they become autonomously motivated as they begin to internalize the value of their learning and accept more ownership in learning. Hence, Ryan and Deci (2017) claim social and contextual factors can create conditions that either promote or decrease the three psychological needs. Although motivation defines an important component mediating teacher learning, relatively few studies have specifically examined this phenomenon. To date, no studies exist that examine how LSOA affects teacher motivation. As a result, I used SDT as a theoretical framework to explore and analyze the contextual factors teachers experience when participating in the LSOA learning process.

Purpose Statement

This descriptive research study explains how LSOA shapes contextual factors which impacts teachers' autonomous motivation and helps to understand how teachers perceived the effectiveness of these factors. Based on inductive thematic analysis, the study's findings offer a description of teachers' experiences that may inform a principal's instructional leadership repertoire. This information can aid principals as they work to select and enact PD based on current research. It is hoped that these results add to an emerging body of literature seeking to promote the confluence of PD with teacher motivation.

Research Questions

Based on the literature, this research study used a qualitative case study research design (Yin, 2018). For this study, I sought to understand how LSOA shapes contextual factors that impact teachers' autonomous motivation. Autonomous motivation informed the case (or unit of analysis), based on a single case study of teachers who participated in a university-sponsored PD

program utilizing LSOA. This type of case study reflects Yin's (2018) conceptualization of descriptive research that attempts to describe a phenomenon in a specific context that researchers may not be able to fully explain under experimental conditions or through the use of surveys. Therefore, this research study endeavored to describe how contextual factors influenced teacher motivation within the context of LSOA by examining how the process of LSOA influenced teacher motivational orientations. The following research questions (RQs) and subresearch questions (SQs) guided this study:

- RQ1. How do teachers perceive the motivational contextual factors offered by lesson study with open approach?

    - SQ1. How do teachers experience competence when participating in LSOA?

    - SQ2. How do teachers experience relatedness when participating in LSOA?

    - SQ3. How do teachers experience autonomy when participating in LSOA?

- RQ2. In what ways does lesson study with open approach connect with teacher motivation?

I collected data from teachers who participated in a university-sponsored mathematics PD program that incorporated the use of LSOA. The data were drawn from semi-structured teacher interviews, the Teamwork Quality Survey (TWQ; Hoegl & Gemuenden, 2001), and written reflections. Together, this data served to triangulate the results of the study, which contributed to the trustworthiness of the overall study and findings. I used thematic analysis (Braun & Clark, 2006) from an a posteriori perspective, supporting an inductive approach.

This research study was supported by an interpretivist paradigm. A qualitative case study research design and approach was used to discover how teachers experienced the phenomenon of motivation within the context of LSOA. The use of a qualitative case study research design and approach is a common approach according to the limited LSOA studies emerging from Thailand. These studies utilized a case study research design and approach to answer their research

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questions. The current research study addressed a substantial gap in the literature, which has not yet been examined, about how LSOA provides opportunities to motivate teachers from an autonomous perspective.

Significance of Study

The research questions provided original contributions to the current research literature. For example, the question "In what ways does LSOA connect with teacher motivation?" centers on understanding how LSOA could create opportunities for teachers to experience competence, autonomy, and relatedness, which, according to SDT, enable teachers to experience autonomous motivation. The results of this investigation may provide additional information in relation to an underresearched area of PD. Moreover, previous studies using SDT have focused on (a) general teacher motivation, (b) burnout, and (c) principal leadership style (Roth, 2014). This study contributes to the field of PD by helping educational stakeholders understand how SDT can connect autonomous motivation to the specific and understudied approach of LSOA in the U.S.

In addition to calling for further research on teachers' motivation and PD, Roth (2014) suggested the general lack of teacher motivational research may be due to "its correlational and cross-sectional nature, which does not allow causal inferences" (p. 23). This research study avoids the quantitative limitation by conducting a qualitative case study designed to explore teachers' perceptions. This allows readers to gain an understanding of how LSOA may provide contextual factors that align with SDT to provide motivation for teachers. Keeping teachers motivated to begin and sustain professional learning reinforces the entire premise of increasing student achievement by increasing teacher learning. An absence of motivation can undermine the positive intentions of PD, thus wasting time and resources (Guskey, 2002). Therefore, investing

time and energy in understanding motivational contextual factors that fall under the control of administrators contributes valuable information for instructional leaders.

Definition of Terms

The following descriptions define pervasive concepts used throughout the study.

- Professional development—refers to the process of educating teachers to further knowledge of their subject and how to best deliver instruction to increase student achievement.

- In-service teachers—refer to employed teachers who have entered the teaching field and have completed their teaching preparation programs.

- Teaching paradigm—refers to a teacher's belief in how students learn, thus influencing how they approach and deliver instruction.

This chapter introduced the idea that staff developers, principals, and policymakers may neglect motivation and the teacher change process when implementing PD. Teacher motivation reflects a critical component as it increases the probability of sustained and committed efforts to enact new pedagogy in the classroom. Teacher commitment is importance when the goal of PD centers on increasing student achievement. Therefore, understanding contextual factors that promote teacher motivation and the change process underscores this research study.

Chapter 2 provides a literature review that examines PD practices promoting teacher learning related to general professional development, as well as mathematics professional development. Additionally, I describe LSOA and how SDT supports contextual factors that may influence teacher motivation. The chapter ends with a discussion articulating how PD might consider motivation when facilitating teacher learning.

CHAPTER 2

LITERATURE REVIEW

School reform movements, based on neoliberal ideology, place more emphasis on school accountability and high-stakes testing as these reforms expand across the nation (Kim, 2018; Lipman, 2011). This focus on accountability places pressure on schools and districts to increase student achievement levels yearly. Because of this ubiquitous pressure, many schools and districts utilize teacher professional development (PD) as a primary technique to accelerate school improvement efforts (Darling-Hammond et al., 2009; Gallucci et al., 2010).

Kozleski and Huber (2010) asserted that policymakers attempted to provide PD guidance designed to increase and promote student achievement in overarching educational acts. For example, the language of legislative policies such as the No Child Left Behind Act of 2001 (2002) and the Every Student Succeeds Act (2015) encourages schools to promote scientifically based research to guide instructional practices (Wayne, Yoon, Zhu, Cronen, & Garet, 2008). The scientifically based instructional requirement, while developed with good intentions, embodied problematic issues because of confusion surrounding research-based instruction and interventions (Kozleski & Huber, 2010). According to Hale et al. (2010), educator confusion continues unabated because these legislative acts offer "no consensus on the definition of empirically based approaches; no agreed-upon curricula, instructional methods, [and] no agreed upon teacher training standards or supervision methods" (p. 228). As a result, recent legislation includes requirements but excludes guidance or detailed explanations on how to meet the requirements. Therefore, educators must reach their own conclusions when determining appropriate interventions and teacher PD choices (Kozleski & Huber, 2010).

Professional Development

Due to the lack of guidance from legislative mandates, decisions related to in-service teacher PD lies in the hands of local school districts and campus administrators. Because of the critical nature of these decisions, this literature review begins by exploring the conditions promoting effective PD from an overarching perspective referred to as General Professional Development (GPD). Additionally, a detailed examination of Mathematics Professional Development (MPD) explains the specific conditions promoting effectiveness for mathematics teachers. This PD section ends with a discussion comparing the effective characteristics of both GPD and MPD.

General Professional Development

The concept of improving a teacher's instructional capacity to directly affect student achievement received credibility in a study conducted by the National Staff Development Council (Darling-Hammond et al., 2009). Based on their findings, a critical connection was established, suggesting that improving a teacher's ability to teach can lead to increased student learning and academic achievement in the classroom. The positive connection between teaching and learning created the foundation for supporting and improving a teacher's content knowledge and pedagogical content knowledge (PCK) through various forms of GPD.

According to Desimone and Garet (2015), researchers generally agree that effective GPD may include some degree of (a) content focus, (b) active learning, (c) coherence, (d) sustained duration, and (e) collective participation. These five elements define the most common best-practice strategies and receive support from various researchers (Garet, Porter, Desimone, Birman, & Yoon, 2001; Showers & Joyce, 1996; Wayne et al., 2008). Additionally, Wayne et al. (2008) reported the PD field generally agrees effective GPD includes (a) active learning,

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(b) subject-specific content, (c) job-embedded location, and (d) sustained exposure to learning. The authors also concluded that PD ought to include coherence followed up with collective teacher participation. In addition to this general agreement, a recent study indicated several factors of GPD typify trending patterns across the US. These factors include (a) moving away from short-term workshops, (b) linking teacher evaluations to PD, and (d) using video to improve and evaluate teaching (Desimone & Garet, 2015).

While Desimone and Garet (2015) provided evidence of general agreement concerning the elements of successful GPD, researching PD exposed fundamental barriers illustrating pervasive difficulties. For example, the presence of innumerable variables presented challenges when connecting teacher learning to student achievement. To illustrate the variety of variables, Avalos (2011) reviewed GPD studies published in *Teaching and Teacher Education* from 2000 to 2010. From the 111 articles selected, Avalos categorized the articles into 15 general themes demonstrating the range of available areas of focus. Avalos suggested that a shift occurred in the 2000s when GPD had moved away from traditional in-service models but specifically acknowledged the complex process and high number of competing variables that convoluted many of the studies.

In addition to the difficulty of researching GPD due to many variables, relatively few studies exist that link PD to student achievement (Whitworth & Chiu, 2015). Yoon, Duncan, Lee, Scarloss, and Shapley (2007) evaluated 1,343 studies focused on establishing a link between PD and student achievement. After applying the criteria for evaluating scientific research based on the What Works Clearinghouse Standards, only nine studies met the standard. All nine studies were conducted between 1986 and 2003 and all of them included elementary teachers. The synthesized results revealed a positive relationship between short-term workshops and student

achievement. In addition, the researchers who conducted the nine studies claimed the one-shot workshop/summer institute, often maligned as the least effective form of GPD, proved effective for student achievement. Yoon et al. (2007) emphasized that workshops/summer institutes included "research-based instructional practices, involved active-learning experiences for participants, and provided teachers with opportunities to adapt the practices to their unique classroom situations" (p. 469). The general characteristics, as defined by Desimone and Garet (2015), applied to the short-term workshop approach to improve effectiveness.

Additionally, Yoon et al. (2007) determined GPD that demonstrated evidence of effectiveness did not include teachers working collaboratively with one another through peer coaching or a train-the-trainer model. Instead, the use of an outside expert who either designed the program or conducted the PD, and then facilitated the implementation proved effective. The results also revealed that teachers who collaborated to identify and solve problems tended to be dismissive of research and stuck with what they thought would work as opposed to focusing on student achievement. Although this research seemed to discredit school-based GPD and teachers working in collaboration, the authors stressed the information did not disprove the value of collaboration. Due to the limitations of their selected research design, the researchers did not collect evidence to either support or not support the value of collaboration (Guskey & Yoon, 2009).

The practices that proved effective, based on the findings of the nine elementary studies, varied. Yoon et al. (2007) reported positive effects when teachers participated in 30 or more hours of PD, as well as deliberate, focused, and sustained follow-up after the initial PD. Success occurred with GPD when it included both specific content and pedagogical knowledge. Teachers transferred their new learning when they learned more about the content and how students

learned that content (i.e., PCK). Yoon et al. suggested the relationship between GPD and student achievement exemplified the difficulty of establishing this link because of a lack of studies employing the use of rigorous scientific methodology, such as experimental or quasi-experimental samples. Their study captured the difficulties of researching GPD; however, when PD focuses on a specific subject area, such as mathematics, similar challenges occur.

Mathematics Professional Development

The challenge of researching mathematics PD increased due to a call to reform mathematics in the United States (U.S.) between 1989 through 2010. The call occurred as a result of the publication of the National Council of Teachers of Mathematics (NCTM) Standards and also by reports produced by the National Research Council and U.S. Department of Education (Borasi & Fonzi, 2002). These organizations called for a change in mathematics instruction to meet the challenges of society's mathematics demands. Such a change involved moving away from procedural memorization of math facts to constructivist (inquiry-based, conceptual) approaches to mathematics. The reforms initiated the effort to increase mathematical conceptual understanding and meaning-making for K-12 children across the nation. The new standards compelled teachers who were previously ensconced in the traditional methods of mathematics instruction to retool their instructional paradigm and entire approach to teaching and redefine their thinking about how students learn the discipline of mathematics. According to Borasi and Fonzi (2002), "Neither typical university courses nor traditional in-service workshops go far enough. Different kinds of experiences are needed if we wish to promote radically different beliefs and practices and create learning communities engaged in reform" (p. vii). As a result, adjusting to the new standards required adjusting instructional pedagogy and PD to help teachers make this difficult transition.

To help teachers bridge the gap between the traditional and new standards, Clark (1994), and Loucks-Horsley and Matsumoto (1999), described specific PD strategies by synthesizing qualitative mathematics literature designed to support teacher learning. Collectively, their seminal work created the foundation of effective elements for PD designed specifically to support the new mathematics standards introduced in 1989.

Qualitative Mathematics Professional Development

Based on the literature and his own experience, Clark (1994) identified 10 key principles to support MPD. These principles met the rigor of the new mathematics standards described by the NCTM. He reported MPD addresses the practical needs of mathematics teachers while allowing for some degree of choice. For example, he believed teachers would demonstrate a change in teaching behavior if they recognized new learning met their needs. Additionally, if they could choose the topic or subject of their new learning, their motivation to change increased. This choice, however, needed to correspond with administrator suggestions because teachers lacked awareness of new initiatives or impending requirements.

Clark (1994) also espoused that teachers needed to internalize a high level of commitment to new learning to encourage effectiveness. This entailed asking participants to implement their new learning in the classroom and reflect afterward. Clark insisted teacher commitment increased when those who initially were hesitant started to see positive results. Additionally, when teachers understood administrators and other teachers provided support, their commitment to the project increased. Teachers willingly changed their (a) knowledge, (b) beliefs, (c) attitudes, and (d) classroom practice if their own learning aligned with their classroom experiences. In other words, if teachers believed their newly learned information

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helped their students, the process of change was embraced and the commitment to make such changes increased.

At the time of publication, Clark (1994) mentioned many teachers worked in professional isolation although emerging evidence suggested teachers could effectively learn from each other. He promoted teacher collaboration as critical to advancing teacher learning and implementing new practices. In addition, he strongly suggested students and parents receive information informing them of the new instructional approaches and how they benefited students early in the change process. Parents of the students involved needed to receive an explanation of the change as well because they had grown accustomed to the traditional approach of teaching mathematics from a drill-and-practice perspective. If all the stakeholders involved were helped to acquire an understanding of the changes that were to happen, it could increase the probability of a smooth transition.

A major component of Clark's (1994) conceptualization included the removal of external, internal, and affective barriers. *External barriers* included (a) a lack of long-term implementation plans; (b) the absence of district resources, funding, and other supports; and (c) failing to understand how school-specific needs should adjust to the design of PD. *Internal barriers* included (a) not giving teachers the time they needed during the day to collaborate, (b) a lack of aligning teacher and student evaluations to the new approaches, and (c) failing to educate stakeholders about new initiatives. *Affective barriers* included failing to obtain commitment and ownership from the teachers and assuming all mathematics teachers had the same level of content knowledge.

Clark (1994) represented one of the first researchers to focus on developing best practices for MPD. He believed his 10 principles, when incorporated into a PD plan, provided an excellent

opportunity to both promote the change process and help teachers learn. Clark supported his belief that MPD endorsed one of the most realistic strategies to promote the widespread implementation of the new NCTM standards.

While Clark's (1994) work focused on supporting mathematics teachers, other researchers concentrated on similar efforts. For example, Loucks-Horsley and Matsumoto (1999) produced comparable results when determining the best way to educate mathematics teachers. Loucks-Horsley and Matsumoto argued that MPD reinforced a critical aspect to improving mathematics education and supported reform efforts. They determined that effective MPD contained the following four elements: (a) content, (b) process, (c) strategies and structures, and (d) context. The *content* of quality MPD improved a teacher's knowledge of the subject matter and helped them understand their specific learners and how teachers learn, as well as how to teach the concepts using specific methods. In reference to content, Loucks-Horsley and Matsumoto explained Shulman's (1986) concept of PCK. According to Shulman, this term encompassed:

> What concepts in a discipline are most appropriate for students of a certain age, how the students come to understand those concepts, what naïve conceptions or misconceptions they are likely to have, and what representations, examples, and experiences help them learn. (1986, p. 6)

This definition supports MPD in that it includes specific instructional techniques and approaches that concentrate on mathematics pedagogy. In other words, Loucks-Horsley and Matsumoto (1999) believed teachers needed to understand how students conceptualized and learned mathematics content, so teachers could develop lessons with deliberate intention. Without this specific understanding, lesson creation and delivery would not necessarily align with mathematics-specific teaching theory.

The second MPD element, *process*, referred to how teachers learn. Specifically, this included (a) building new learning on what mathematics teachers already knew about learner-centered structures, (b) providing timely feedback by promoting reflection through assessment-centered approaches, and (c) providing community-centered opportunities for teachers to work together (Loucks-Horsley & Matsumoto, 1999). Additionally, they suggested traditional PD (a) taught a new skill, (b) provided curriculum, (c) answered questions, and (d) taught fidelity of implementation. However, to provide a more direct path between new learning and teacher application, the authors believed individuals teaching the faculty should use an inquiry-based approach. This approach reduced prescribed solutions in favor of analyzing student artifacts, such as student work, assessments, and journals to facilitate deep and meaningful discourse and problem-solving among teachers.

For the third element of MPD, *strategies and structures*, Loucks-Horsley and Matsumoto (1999) examined the 15 MPD approaches that are commonly used for mathematics and grouped them into five categories: (a) immersion, (b) curriculum, (c) examining practice, (d) collaborative work, and (e) vehicles and mechanisms. *Immersion* teaching asks participants to practice or do math, so they can learn how to solve problems. *Curriculum* focused on introducing teachers to a new curriculum and demonstrating how to teach the new content. *Examining practice* focused on an inquiry approach in which teachers learned how to examine artifacts in order to understand how their students learned; furthermore, this strategy enabled teachers to adjust their lessons as a result of the information obtained. This also included data collection and conducting action research to develop solutions. *Collaborative work* involved building a support network or professional culture focused on student learning. This included partnerships with content experts such as university faculty, mentors, or instructional specialists. *Vehicles and*

mechanisms referred to traditional workshops or institutes taught by experts, which according to the authors, could be effective if they used applicable design elements and met the needs of teachers.

The fourth element, *context*, referred to the school environment/culture characterizing the expectations and support for teacher learning and growth, which has the potential to enhance PD efforts. For example, schools that promoted collaborative cultures increased teachers learning from one another, which encouraged a focus on student learning. School leadership dedicated to MPD ensured that teachers received the resources and sustainability to improve learning that focused on school-wide goals of student learning.

In summary, Loucks-Horsley and Matsumoto (1999) reported (a) content, (b) process, (c) strategies and structures, and (d) context-created conditions likely to enhance the success of MPD approaches, which included improving content knowledge so teachers would better understand how students learned mathematics and recognized which teaching theories promoted student learning. After initially creating disequilibrium, quality MPD should support new learning with inquiry approaches and peer feedback cycles. These MPD conditions worked well in a context of support personified by school leadership who provided (a) alignment, (b) beliefs, (c) resources, and (d) culture to promote sustained efforts and encourage new learning.

Both Clark (1994), and Loucks-Horsley and Matsumoto (1999), reported effective MPD qualities derived from qualitative studies, judgement, and personal experience. They justified their decision to use these above-mentioned subjective forms of evidence because of the complexities involved with the many variables of teaching and learning. Both repeatedly justified their use of qualitative research over quantitative because of the complexities associated with the variables that convoluted quantitative research methodology. This view, however, does

not represent the stance shared by all researchers. Three prominent studies reported quantitative research that sought to determine which MPD model most effectively addressed teacher learning. Scher and O'Reilly (2009), and Gersten, Taylor, Keys, Rolfhus, and Newman-Gonchar (2014), both conducted research studies based on experimental and quasi-experimental research designs, while Antoniou and Kyriakides (2013) conducted a quantitative group-randomization study investigating the PD model of the dynamic integrated approach. All three studies continue the MPD discussion from a quantitative perspective as opposed to a qualitative standpoint.

Quantitative Mathematics Professional Development

To demonstrate the quantitative perspective of MPD, Scher and O'Reilly (2009) conducted a meta-analysis with the goal of evaluating high-quality quantitative research to support general assumptions characterizing effective MPD. The analysis started with 145 quantitative studies and was reduced to seven mathematics studies after applying their inclusion criteria. Their criteria included: (a) PD mathematics focus, (b) K-12 schools in the U.S., (c) studies ranging from 1990 to 2007, (d) experimental or quasi-experimental designs, and (e) the inclusion of effect and sample sizes. Although Scher and O'Reilly considered the studies quantitative in nature, a majority of the studies did not meet gold standard research as defined by the What Works Clearinghouse; only one study met this highest quality criteria. As a result, Scher and O'Reilly suggested readers not over interpret the evidence presented.

In their meta-analysis, Scher and O'Reilly (2009) compared the effect sizes of MPD based on (a) duration, (b) intervention components, and (c) focus. Their data suggested teachers who participated in multiple years of MPD had an effect size of .59 and teachers who received 1 year of MPD had an effect size of .14. This suggested the students who were taught by teachers

who participated in MPD over multiple years had higher levels of student achievement as compared to students of teachers who participated in MPD for one year.

Scher and O'Reilly (2009) defined *focus* as the content knowledge taught in the MPD. Content knowledge included (a) mathematics content knowledge, (b) pedagogy, or (c) a combination of both. Ultimately, they could not limit their analysis to the effects of mathematics content knowledge; yet, they determined an effect size of .56 for MPD focusing on a combination of content and pedagogy. Programs focused only on pedagogy had an effect size of .07. The difference in effect sizes suggest MPD approaches that included a focus on both content and pedagogy knowledge had a more pronounced effect on student achievement compared to approaches that included only pedagogical knowledge. The results did not allow the authors to be more specific about the actual content taught during the MPD because they did not have access to that information.

Scher and O'Reilly (2009) reported that more intensive forms of MPD are effective for mathematics teachers and found that participation in more sustained MPD—lasting multiple years and including mathematics content and pedagogy content knowledge—yielded beneficial results for teachers. Scher and O'Reilly suggested follow-up support systems such as coaching and intervention reflected a positive effect size; however, they failed to describe the coaching and intervention components with any level of detail. Again, due to the low numbers of studies and methodological variety of the studies in this meta-analysis, Scher and O'Reilly recommended readers interpret the results as suggestive.

Like Scher and O'Reilly (2009), Gersten et al. (2014) conducted a comparable analysis of quantitative mathematics studies designed to determine causal relationships between MPD approaches and student achievement. Their review initially identified 910 studies focused on

GPD approaches designed for teachers. After applying their inclusion criteria, the number was reduced to five studies. The research criteria included: (a) K-12 teachers who worked in the U.S., (b) a focus on MPD, and (c) the What Works Clearinghouse Standards.

According to Gersten et al. (2014), the results of two studies indicated a causal relationship between MPD and student achievement. The strongest relationship occurred as a result of a lesson study focused on fractions (Lewis & Perry, 2017). The research design included a randomized controlled trial consisting of 213 teachers and 1,059 students ranging from second to fifth grade. The teachers participated in a series of collaborative group meetings over a period of five months and had access to consultants. The researchers developed a test to assess the students' understanding of fractions and the results demonstrated significance with an effect size of .84. According to the What Works Clearinghouse (Gersten et al., 2014), an effect size greater than 0.25 characterizes a substantively important result. Gersten et al.'s (2014) results suggested the in-depth study of high-quality curriculum in a collaborative environment, which encouraged feedback cycles (i.e., lesson study) based on students' reactions to instruction, increased the achievement of students.

The second approach, which according to Gersten et al. (2014) demonstrated a causal relationship, combined university courses with follow-up workshops (Sample McMeeking, Orsi, & Cobb, 2012). To illustrate, teachers enrolled in two summer mathematics courses designed to teach inquiry-based instructional models for middle school and older elementary school students. The courses focused on mathematics content 80% of the time and PCK 20% of the time. The four follow-up workshops, conducted during the school year, focused on lesson design based on summer learning. Students receiving instruction from teachers who participated in both summer courses and all workshops had students who performed significantly higher on their state

standardized assessments reaching an effect size of .20. In other words, when teachers developed

deeper PCK and delivered that knowledge through inquiry-based approaches, students'

mathematics achievement increased. Additionally, the study supported sustained implementation

over multiple years, which included various forms of follow-up support after initial learning took

place (Gersten et al., 2014).

While Gersten et al. (2014) reported on the importance of follow-up support, Antoniou

and Kyriakides (2013) specifically focused on teacher sustainment after PD ended. They

identified a gap in the research related to a lack of research measuring the sustainability of PD

approaches once they ended. Citing several studies, the authors suggested that once a PD

experience concluded, the teachers no longer implemented the new strategies and reverted to

previous practices. The authors conducted a quantitative group-randomization study that

investigated the PD model of the DIA and its sustainability one year after its implementation. To

begin, they described the five stages of teaching skills ranging from the basic, direct teaching

approach, to the advanced, differentiated and student-centered approach. Antoniou and

Kyriakides reported that results from previous research studies revealed that teachers exhibiting

characteristics associated with higher stages produced greater results with students. For that

reason, Antoniou and Kyriakides developed the DIA of PD, suggesting that teacher learning

should focus on the grouping of characteristics associated with the stages of the dynamic model.

Additionally, they argued that teachers who possessed varying levels of experience needed

various skill improvement options in order to meet their varied and specific needs. Antoniou and

Kyriakides identified teacher need by collecting data based on observations of their classroom

behaviors. This information then guided the type of learning opportunities offered.

A statistical significance between stage of teaching skill and student achievement existed (Antoniou and Kyriakides, 2013); teachers in Stage 1 had the lowest student achievement and teachers in Stage 4 had the highest student achievement. Teachers participating in the DIA approach had higher student outcomes compared to teachers using a holistic, alternative approach. The alternative approach allowed teachers to select their own teaching skill and reflect on its implementation. Students taught by teachers using the alternative approach did not make any statistically significant progress; yet, students of teachers in the DIA group made significant progress.. In contrast, the DIA not only focused on reflection, it required teachers to focus on the dynamic skills that met their immediate needs. One year after the PD opportunity, both groups remained static in their level of student achievement.

In conclusion, Antoniou and Kyriakides (2013) stated that the findings of their study supported the following argument: "It is time to stop assuming all teachers are in possession of effective cognitive skills that develop naturally and without the need for training and reflection addressing the specific needs of teachers" (p. 9). Their argument underscored the need for teachers to have access to more knowledgeable others or similar access to instructional strategies that correlated to positive student outcomes. The author claimed that teachers do not always appropriately choose the correct skills on which to place their focus to receive the appropriate feedback that allow them to make effective adjustments. These findings and conclusions suggest that teachers need to acquire additional knowledge and skill in utilizing targeted and specific instructional strategies that align with their appropriate stage. Antoniou and Kyriakides' study and personify the scope of many studies related to PD in a mathematics context because the PD does not extend past a school or district-level faculty. Consequently, the scope remains limited. Nevertheless, the limited scope can be expanded when considering a systems approach.

Systems Approach

Within the past decade, researchers have conceptualized MPD from a larger perspective that extends beyond researching effective characteristics to include all-encompassing system considerations (Koellner & Jacobs, 2015; Marrongelle, Sztajn, & Smith, 2013). By understanding how certain PD approaches support various contexts, policymakers may be able to make better choices when deciding which approach will meet teacher needs. Koellner and Jacobs (2015) argued that the litany of PD approaches should exist on a single continuum focusing on adaptability. They suggest viewing PD holistically to understand how its individual components become operationalized in certain contexts. They specifically state, "It is important to point out that our classification approach treats PD models as 'systems,' rather than sets of features or effective characteristics" (Koellner & Jacobs, 2015, p. 52).

Additionally, Marrongelle et al. (2013) supported a systems perspective by reinforcing the need to support teachers properly when implementing the Mathematics Common Core State Standards. They stressed how the standards increased the need to teach conceptually to promote high-level application and deep understanding. Referring to teacher implementation, the authors stated, "Without strong teacher engagement and preparation, the transition to the MCCSS will bring more challenges and disappointments than actual changes" (Marrongelle et al., 2013, p. 202). To meet this challenge, they assembled a team of experts who suggested a set of PD recommendations addressing how to provide nationwide teacher PD.

This set of recommendations from Marrongelle et al. (2013) created an overarching framework informing PD from a systemic viewpoint. To illustrate, they asserted the goal of the recommendations characterized how various PD approaches meet the needs of users. The recommendations do not designate or prescribe one specific PD approach over another.

Therefore, the framework supports a systemic approach by stressing the wide-ranging connection and coherence between new initiatives and all stakeholders. Teachers receive support, in addition to all district staff, as well as parents and state policymakers. By involving everyone, the system establishes supports, monitors, and improves the PD process that ultimately leads to continuous student improvement.

Discussion

After reviewing the characteristics of effective MPD, several similarities, as well as differences, emerged between GPD and MPD approaches. The similarities included agreement of elements derived from qualitative studies and the difficulty using quantitative methodology. The differences between the two included mathematical knowledge and instructional approach. To further illustrate the differences, much discussion centered on the type, amount, and role that mathematical content knowledge plays when educating teachers. Additionally, an ongoing debate endures on the proper instructional approach centered on conceptual versus procedural instruction. Although present in MPD, these specific differences, such as mathematical knowledge and instructional approach do not exist in GPD.

The information revealed in this literature review suggested effective characteristics generated from qualitative research and convoluted quantitative methodology express meaningful similarities between GPD and MPD. For example, when identifying elements promoting effective GPD, they dovetail with the elements of effective MPD. When characterizing GPD, researchers generally agree staff developers may include (a) subject-specific content, (b) active learning, (c) coherence, (d) sustained duration, and (e) collective teacher participation situated in a job-embedded campus environment (Desimone & Garret, 2015; Wayne et al., 2008). These critical elements of GPD parallel those identified by MPD programs

(Clark, 1994; Loucks-Horsley & Matsumoto, 1999; Marrongelle et al., 2013). As discussed, MPD also considers these elements critical to successful implementation. Although researchers apply various terminology, they certainly address the same issues. In reference to MPD, Clark (1994) made use of this statement, "Recognize that changes in teachers' beliefs about teaching and learning are derived largely from classroom practice; as a result, such changes will follow the opportunity to validate, through observing positive student learning, information supplied by professional development programs" (p. 42), to describe the necessity to make substantial connections between new learning and the teacher's classroom context. This concept describes coherence as articulated by GPD researchers Desimone and Garret (2015), and Wayne et al. (2008), but they certainly refer to the same dimensions.

While GPD and MPD share similar effective elements, based on qualitative research studies, the second similarity included convoluted quantitative methodology. Both GPD and MPD share the difficulty of measuring PD due to the difficulty of choosing what to measure and the limited number of studies meeting gold-standard research criteria (Gusky, 2000). Researchers understand the logistical and ethical difficulties inherent in creating laboratory conditions in a real-world public school campus with students and faculty. Gusky (2000) explained most GPD studies reveal what does not work, as opposed to reporting what does work. According to Gusky, the focus on what does not work occurs because of the confusion surrounding what measurement criteria most effectively determines what works in GPD. For example, some studies measure teachers' reactions to the learning experience, while others measure teacher behavioral or commitment change. A few studies measure student learning, although student learning is measured infrequently in relation to other measurement options (Gusky, 2000). These discrepancies make it difficult to analyze and synthesize results across studies. Additionally,

meta-analysis studies exhibit limited value because they focus on main effects that must remain consistent across studies. Because numerous studies do not utilize the same main-effect techniques, meta-analysis researchers typically analyze small numbers of studies reducing the magnitude of their results.

This literature review exposed the problem of small meta-analysis studies, as articulated by Guskey (2000), for both GPD and MPD. To illustrate this phenomenon in GPD, the meta-analysis performed by Yoon et al. (2007) started with 1,343 studies but analyzed only nine. The nine studies represented the elementary level; therefore, the results did not generalize to secondary teachers. In reference to MPD meta-analysis, both Scher and O'Reilly (2009), and Gersten et al., 2014), included a small number of studies as well. Scher and O'Reilly's meta-analysis started with 145 studies, which narrowed to seven. Gersten et al. initially identified 910 studies, which they reduced to five. Although not the only criteria, dissimilar main effect techniques contributed to the reduction of studies. Including such low numbers in a meta-analysis study limits their value (Guskey, 2000), and these limitations occurred for both GPD and MPD meta-analyses. Consequently, Scher and O'Reilly (2009) emphasized this difficulty when they stated, "Unfortunately, very little evidence of the link between professional development programs and changes in teacher practices are available" (p. 214). Such a conclusion reveals similar frustrations were shared between studies of GPD and MPD in relation to quantitative methodology.

Additionally, many of these quantitative studies, both GPD and MPD, did not include detailed explanations and important information about the PD intricacies. This issue appeared in Scher and O'Reilly's (2009) meta-analysis since they could not describe how coaches supported the teachers. They reported a strong effect size, but anyone attempting to replicate any of the

coaching models on a campus would have to do so without any practical guidance. From a GPD standpoint, Yoon's et al. (2007) results similarly did not provide explicit details allowing practical guidance. This PD research issue was also posed by Gusky (2000) when it surfaced in GPD and MPD research studies included in the literature review (Borasi & Fonzi, 2002; Gersten et al., 2014; Loucks-Horsley & Matsumoto, 1999; Sample McMeeking et al., 2012; Yoon et al., 2007).

Although similarities exist between GPD and MPD, the literature indicated differences as well. These differences included mathematics content knowledge and instructional approaches. To illustrate, there exists an ongoing debate as to the worth of mathematics content knowledge in the classroom. This focused debate on teacher knowledge does not present itself in GPD literature. Additionally, MPD focuses on addressing constructivist (inquiry-based, conceptual) instructional approaches to overcome embedded traditional approaches that do not readily surface in GPD literature. Although GPD identified content focus as a critical element, MPD takes this concept to a deeper level. The knowledge debate over content focus illustrates one of the differences between GDP and MPD. Although it might seem obvious to assume a teacher's level of mathematics content knowledge influences student achievement, the research literature indicates mixed opinions. According to Hattie (2009), very little research exists to justify claims suggesting that a teacher's content knowledge and PCK influenced student achievement. His meta-analysis suggested teacher subject-matter knowledge demonstrated a very low effect size of .09. To support his argument that teacher subject-matter knowledge did not influence student achievement, he cited a meta-analysis (Ahn & Choi, 2004) focusing on mathematics teachers' content knowledge. The results indicated a very low effect size of .12, suggesting no causal relationship between mathematics teacher content knowledge and student achievement. Although

Hattie, and Ahn and Choi, explained the low effect sizes in their findings, not everyone agreed with their results.

Sample McMeeking et al. (2012) made the argument that quantitative research studies, such as that conducted by Hattie (2009), employed poor measures based on proxy variables. Proxies used in this type of research related to formal schooling (such as degrees, classes, and certifications). Sample McMeeking et al. argued proxies do not accurately measure the kinds of knowledge employed in a classroom and the hundreds of decisions a teacher makes when planning and implementing quality mathematics instruction. Additionally, Sample McMeeking et al., (2012) insisted that meta-analysis studies suffered from "methodological flaws such as aggregation bias, in the type of data used (i.e., cross-sectional versus longitudinal) and in the use of composite measures for student and teacher outcomes" (p. 162). Sample McMeeking et al. believed teacher subject-matter knowledge did make a difference to student achievement when the teachers developed deeper mathematics content knowledge and delivered that knowledge through inquiry-based approaches. However, simplistic proxy measures lacked the capability to measure or capture such a complex classroom phenomenon.

Scher and O'Reilly (2009) addressed the issue of mathematics content knowledge by suggesting experts generally agree that it does impact student achievement, but disagreement exists as to what type of knowledge impacts student achievement the most. For example, Scher and O'Reilly stated researchers referenced (a) teacher knowledge as a general understanding of the discipline, (b) pedagogical knowledge as understanding how students learn, and (c) PCK as understanding concepts and information that embody the essence of the subject.

Darling-Hammond and Ball (1998) emphasized the critical nature of mathematics content knowledge but also insisted teachers needed to know how to apply it, which many studies on

subject-matter knowledge do not address. Sample McMeeking et al. (2012) surmised, "The means by which teacher knowledge is used in the classroom is as important as the amount of knowledge itself" (p. 163). If teachers do not understand core concepts or major ideas that fundamentally underlie the discipline, they struggle to help students understand and build coherent schemas of information. Moreover, Sample McMeeking et al. reinforced the importance of listening to understand how students conceptualize and think about mathematics. This knowledge promotes teaching for understanding instead of asking the students to memorize steps for solving problems. The discussion surrounding mathematics content knowledge includes general, pedagogical, PCK, and proxy and how this knowledge unfolds in the classroom. However, not all researchers agree on the effectiveness of each type.

The second major difference between GPD and MPD includes the debate of procedural versus conceptual approaches. The release of NCTM standards in 1989 reignited the push to supplant the traditional approach of mathematics instruction with an inquiry-based approach. The standards described in this publication called for (a) mathematics reform, (b) a deeper conceptual understanding of mathematic concepts, and (c) the elimination of rote memorization of steps (Clark, 1994). The inquiry-based instructional method exemplified the most recommended approach to meet these new conceptual standards (Borasi & Fonzi, 2002). Additionally, Borasi and Fonzi (2002) suggested using MPD to facilitate these changes expressed the most effective manner to facilitate compliance. They understood a significant teacher shift would take time, especially for established teachers who needed to unlearn old practices in order to learn and understand new assumptions about how to teach and how students should learn.

To understand the difficulty of internalizing a conceptual approach after using a procedural approach, one should examine the results of Stigler and Hiebert's (1999) study. This

study analyzed the results of the 1999 Third International Mathematics and Science Study (TIMSS) from seven countries, including the U.S, and compared videotaped lessons of eighth-grade mathematics classes from each country. The countries included Australia, the Czech Republic, Hong Kong, Japan, The Netherlands, Switzerland, and the U.S. The order of this list reflected the order of achievement on the TIMSS, with Australia scoring the highest and the U.S. scoring the lowest.

When compared to other countries, eighth-grade mathematics classes in the U.S. executed unchallenging, fragmented curriculum with procedurally oriented approaches to instruction. These classroom characteristics became evident after examining the breakdown of specific data. When Stigler and Hiebert (1999) dichotomized the mathematics problems by type, exercise-type and application problems emerged with persistent frequency. The authors defined *exercise-type problems* as teachers instructing students to answer mathematics questions without any context using a predetermined set of steps, while *application problems* required students to consider an adjustment to predetermined steps, based on context, to solve problems. Students in the U.S. completed the lowest number of application problems, compared to other countries. When creating or applying new procedures to new problems, American teachers preferred practicing familiar problems at a much higher rate. This lack of application and creation led to lower amounts of challenging curriculum. American teachers did not include mathematical reasoning in the form of generalizing or justification. Taken together, the persistent use of exercise-type problems caused U.S. students to experience less-challenging lessons in comparison to students in other countries.

The results of Stigler and Hiebert's (1999) study suggested American teachers often defaulted to procedural methods. even if the lesson initially included a conceptual design. For

example, during the lesson when students struggled, teachers in all countries scaffold back to using procedures; however, this return to a procedural approach occurred in U.S. classrooms at a higher rate compared to other countries. According to the authors, "virtually none of the making connections problems in the U.S. were discussed in a way that made the mathematical connections or relationships visible for students" (Hiebert et al., 2005, p. 120). Teachers in the higher-achieving countries focused more on the conceptual component of mathematical learning, as opposed to a concentration of procedural understanding. As a result of this information, the authors suggested at the time of publication that the goals of the NCTM standards eluded both teachers and students. They suggested a comprehensive reevaluation of the entire system of teacher preparation was necessary to correct the issue. This included an adjustment in professional practice that focused on teaching constructivist, inquiry-based, methods consistently by pre- and in-service K-12 teachers and an organized system for sharing teacher knowledge.

Olson et al. (2014) conducted a study to understand how mathematics teachers evaluated and perceived how their teaching changed when examining high-challenging mathematics standards. The authors explained the CCSSM maintained and propagated the standards described by the NCTM, which first published challenging mathematics standards in 1989. After the publication of the NCTM mathematics standards, studies revealed a great deal of variation in how teachers aligned their teaching with the new standards. Some met the goals of teaching to the higher standards, while others maintained their traditional approach to mathematics instruction. The purpose of their study examined how teachers perceived the rigor of the CCSSM standards and their role in relation to them.

The results suggested teachers interpreted the higher-level standards through the lens of a traditional approach. For example, one standard dealt with "mathematical modeling as a process

of doing and learning mathematics" (Olson et al., 2014, p. 17). The authors interpreted this standard as students will develop mathematical models to predict and explain real-world phenomena, while the teachers interpreted this standard as how "*they* are the ones responsible for modeling how to do mathematics in classroom settings" (Olson et al., 2014, p. 17). When asked to explain how the new standards influenced their teaching, 61% described a teacher-oriented approach, as opposed to a student-oriented approach. According to the authors, teachers who learned mathematics under a traditional drill-and-practice approach continued to conceptualize teaching and learning from that perspective. As a result, Olsen et al. stressed the importance that PD address the underlying beliefs of a teacher-centered approach in an effort to create a paradigm shift to student-centered approaches that better met the requirements of the standards.

This issue of using MPD to initiate and sustain a paradigm shift to meet new and challenging standards exemplifies a unique phenomenon when compared to GPD. However, experiencing differences between GPD and MPD should not come as a surprise. Mathematics PD, as a field, illustrates the challenges faced by teachers and staff developers when attempting to change teaching beliefs and teaching paradigms. The critical information presented in this section revolves around the teacher-change process. For true change to happen, teachers embedded in traditional approaches must unlearn how they interact with curriculum and restructure their pedagogical thinking and how students interact with the curriculum. Changing such fundamental beliefs and ingrained patterns of behavior characterizes an impressive call to action. Moreover, Supovitz, Mayer, and Kahle (2000) determined mathematics teachers with higher levels of experience subsequently expressed higher levels of anxiety when learning inquiry-based approaches. Conversely, mathematics teachers with lower levels of teaching experience voiced less anxiety when learning the same approach. Therefore, MPD should

consider and address the difficult challenge of changing a teacher's deeply engrained teaching paradigm in addition to increasing content and PCK.

In conclusion, this section illustrated how both quantitative and qualitative research characterizes effective PD from a general and mathematics specific perspective. Both contribute to the overall knowledge of the field; however, I argue qualitative research produces valuable information when studying and researching PD approaches. The limitations associated with quantitative approaches produce limited information. These limitations include (a) the lack of consistent measurement criteria, (b) the lack of studies sharing compatible effect size information, (c) the lack of program description, and (d) the use of proxy variables all contributed to results that created more questions than answers. Therefore, I assert the results of qualitative research offers rich descriptions of effective characteristics that can appropriately guide practitioners. The use of a systems approach provides ideas and guidance on how PD can support teachers from broad and far-reaching perspectives. Using this existing knowledge to create and select PD programs may guide policymakers as mathematics teachers continue to make their instructional paradigm shift.

Lesson Study with Open Approach

Researchers have suggested American teachers have not successfully transitioned to a constructivist, inquiry-based, instructional approach (Olson et al., 2014; Stigler & Hiebert, 1999; Supovitz et al., 2000); however, other nations questioned the quality of their mathematics education after the 1999 TIMSS, as well. Thailand reevaluated their mathematics instructional practices with striking similarity to the U.S. Based on the 1999 TIMSS, as well as the 2003/2006 Program for International Student Assessment, Thailand compared unfavorably to other nations in mathematics achievement. Additionally, they enacted reforms under the National Education

Act in 1999 to improve the quality of mathematics classroom instruction. At that time, Inprasitha et al., (2012), claimed the current trend in Thai mathematics instruction centered on rote memorization of procedural steps to solve problems. Instruction of this nature was comprised of delivering lessons through the lecture format using standardized test scores to judge student understanding. This teacher-centered philosophy did not establish space to allow students to create or construct their own understanding or focus on their learning process. This technique boiled down to "telling students about mathematics" (Inprasitha et al., 2012, p. 1504) as opposed to creating learning opportunities to allow for conceptual understanding. Asking students to memorize steps through the repeated practice of homework problems led to poor performance across the country. Student creativity, divergent thinking, and enthusiasm became stagnate as students failed to think logically. Even after required reforms, the Thai teachers, like their American counterparts, failed to change their instructional paradigms; both countries maintained their hardwired traditional instructional approaches.

To provide PD predicated on changing deep-seated teacher beliefs, as well as improving student mathematics conceptual understanding, M. Inprasitha introduced LSOA (Kongthip et al., 2012) in selected Thai schools. After 11 years of implementation, many Thai researchers believed the concept of LSOA embodied the best learning system for both teachers and students to facilitate mathematical conceptual understanding (Chaovasetthakul et al., 2017; Jaijan & Loipha, 2012; Jaijan & Suttiamporn, 2013; Kongthip et al., 2012; Panbanlame, Sangaroon, & Inprasitha, 2014; Saengpun & Inprasitha, 2012).

Lesson Study

M. Inprasitha's conceptualization of LSOA combined the PD approach of lesson study with the lesson cycle termed *open approach*. To understand LSOA in its entirety, one must

understand the background of lesson study first and then understand the lesson cycle of open approach. *Lesson study* has transpired as a scientific activity to improve teaching for over 140 years in Japan. Japanese educators introduced the concept in 1870 and it became a consistent form of PD in 1880 (Isoda, 2015). Lesson study characterized an approach to PD, but it also supported creating mathematics learning theory. According to Isoda (2015), "Lesson Study in Japan is a scientific activity for teachers who try to develop their own theories, which are used for developing and sharing better practices" (p. 82). This statement reinforces the depth of study lesson study can facilitate if applied with rigor and commitment.

Lesson study exemplifies a method of teacher PD in which teachers work collaboratively to (1) plan lessons, (2) observe how students react to the lessons, and then (3) adjust the lesson based on student reactions. Lesson study incorporates a three-step cycle of continuous improvement designed to adapt to the specific learning needs of students within their unique environment and context. The three-step cycle allows teachers to actively construct their own learning based on their interests and inquiry of student learning. Teacher collaboration begins the cycle of inquiry when a group of teachers seek to improve student outcomes. This collective effort ultimately centers on student understanding because knowing how students comprehend the lesson informs instructional adjustments allowing teachers to fine-tune delivery and activities to better meet student needs. Therefore, the first phase includes developing lessons designed to reveal and make student learning visual. The second phase investigates student thinking when one faculty member teaches a live lesson while the remaining teachers, who assume the role of observers, record data documenting student learning. Murata (2011) insists the live research lesson exemplifies the distinguishing characteristic of lesson study, making it unique in comparison to various PD approaches, such as teacher research or action research. The live

lesson creates the unique opportunity for teachers to expose their own knowledge and understanding in nonthreatening ways, thus promoting deeper levels of teacher learning. This leads to the last phase, reflection, which facilitates lesson adjustments. The reflection phase leads to multiple discussions and iterations designed to improve student outcomes by improving the quality of the lesson (Suriyon et al., 2013).

Lesson study helps teachers create shared meaning and understanding of new or different instructional approaches, curriculum, and instructional sequences. Moreover, lesson study allows teachers to adapt strategies or techniques to meet the needs of their unique context and situations, thus supporting their local community. The lesson study process includes meeting the unique needs of their students with the available resources and knowledge at their disposal. This can meet their practical needs as they work to bridge the gap between theory and practice.

In lesson study, student learning embodies the confluence of content and skillfully crafted lessons. Murata (2011) reinforces this idea when he asserts:

> This interactive teaching requires teachers to know how students *typically think* and *express their understanding* so that teachers can effectively facilitate their learning by weaving together different ideas. Teachers subsequently use this knowledge to provide experiences for students that encourage building connections among concepts and ideas. (p. 4)

Lesson study helps teachers see instruction, not as a one-way dissemination of knowledge from the teacher to the students, but as a two-way communication process. Teachers actively, with deliberate intention and action, collect information from students to further inform how they interpret the activities of learning.

A critical element of lesson study includes the live or research classroom lesson. The experience heightens meaning for participating teachers because they experience how the individual components of a complex classroom combine to inform student learning. For

example, due to the complex nature of delivering instruction, a teacher cannot focus their attention on understanding how every student perceives the lesson. Therefore, teachers performing the role of observer focus solely on collecting data providing information on how students interpret the meaning of the lesson, because they escape the typical duties of controlling and teaching an entire class. Murata (2011) supports this assertion by stating, "When experienced teachers come together and observe a live lesson, their expert knowledge comes to the surface as they interpret the effectiveness of the lesson and discuss it in the debriefing" (p. 5). The observers' interpretations and the debriefing following reinforce how the live lesson helps teachers make connections between their intended outcomes and realistic student interpretations. In sum, the live lesson facilitates the critical element of the lesson study cycle because it allows observers to obtain critical information needed to adjust lessons during the reflection phase.

Although the live lesson defines the essence of lesson study, the concept of supporting teachers with a content expert or more knowledgeable other deserves attention. Murata (2011) asserts, "In some research lessons, knowledgeable others from outside the lesson study group are often invited to observe the lesson and provide comments and make suggestions for the research lesson at the end of the post-lesson discussion" (p. 5). The more knowledgeable other has a specific role. Their role centers on identifying how the lesson or student understanding connects to theory and places this conclusion in the context of effective learning. Therefore, the more knowledgeable other identifies an overall understanding of student learning in the context of the school's environment. However, before a more knowledgeable other joins a teacher team, Murata reminds us the position does not evaluate the teacher from a traditional perspective of identifying deficiencies to improve teacher performance. Hence, an individual assuming the role

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of more knowledgeable other avoids providing feedback on what the teacher should do differently to make the lesson more effective.

Open Approach

While the process of lesson study promotes continuous improvement, it does not specify or endorse a specific lesson cycle. However, a lesson cycle designed to promote mathematical conceptual understanding has existed in Japan almost as long as lesson study itself. Similar to lesson study, the concept of open approach originated from Japanese tradition. Shimizu described a method of teaching mathematics in 1924 requiring students to solve open-ended problems. During that time, mathematics educators considered the approach too difficult. However, open approach gained traction over time as a viable and realistic lesson cycle. In the 1960s, Japan stressed the importance of developing mathematical thinking and Shimizu's method eventually developed into the open-ended and problem-solving approach, which expanded in the 1980s (Isoda, 2015). According to Isoda (2015), open approach originated on the theory "of teaching for developing children who learn mathematics by and for themselves" (p. 82). This stressed the need for teaching mathematical metacognitive strategies, as well as teaching for conceptual understanding, which allow students to apply mathematical concepts to new situations.

Open Approach in Thailand

Although based on Japanese ideology, M. Inprasitha has operationalized open approach in Thailand for mathematics instruction (Kongthip et al., 2012). With this in mind, the Thai approach supports students exploring their own solution strategies under the guidance of a teacher who does not provide answers to problems. Teachers design mathematics lessons to help students develop deep understanding of the principles and general rules of mathematics, with the

outcome that students create multiple ways to solve problems. Teachers create classroom activities that bridge the gap between real-world ideas and mathematical concepts.

The activity of solving open-ended problems creates space for the confluence of real life and mathematics. The addition of real-life experiences, as applied by the experiences of each individual student, helps students understand the abstract conceptual ideas of fundamental mathematical principles. By asking students to solve open-ended mathematics problems via applying examples based on their cultural experiences, the learning becomes individualized and more meaningful to each child (Suthisung & Inprasitha, 2012). Again, this application of individual experience, based on student choice, helps make abstract concepts more real and understandable.

To meet this challenge of incorporating relevant life experiences with solving open-ended problems, M. Inprasitha combined open approach into the lesson study cycle. As a result, Inprasitha used the problem-solving approach as a way to introduce the process of lesson study because it promoted student-centered activities and the open-ended problem allowed observers to better see and understand how students think about mathematics. Inprasitha termed this confluence between the two models as lesson study with open approach (LSOA) (Inprasitha et al., 2012). There are four distinct steps of the open approach lesson cycle: (1) problem posing, (2) student self-learning, (3) whole class discussion, and (4) summarization (Suriyon et al., 2013). To begin, the teacher introduces an open-ended problem to the class designed to have multiple solutions. The second phase of students' self-learning provides time for students to explore the problem, and the third phase, whole class discussion, encourages students to describe their understanding of mathematic concepts in their own words based on their lived experiences.

The last phase, summary with connection, allows the teacher to make connections between student thinking and mathematics principles to clarify student understanding (see Figure 2).
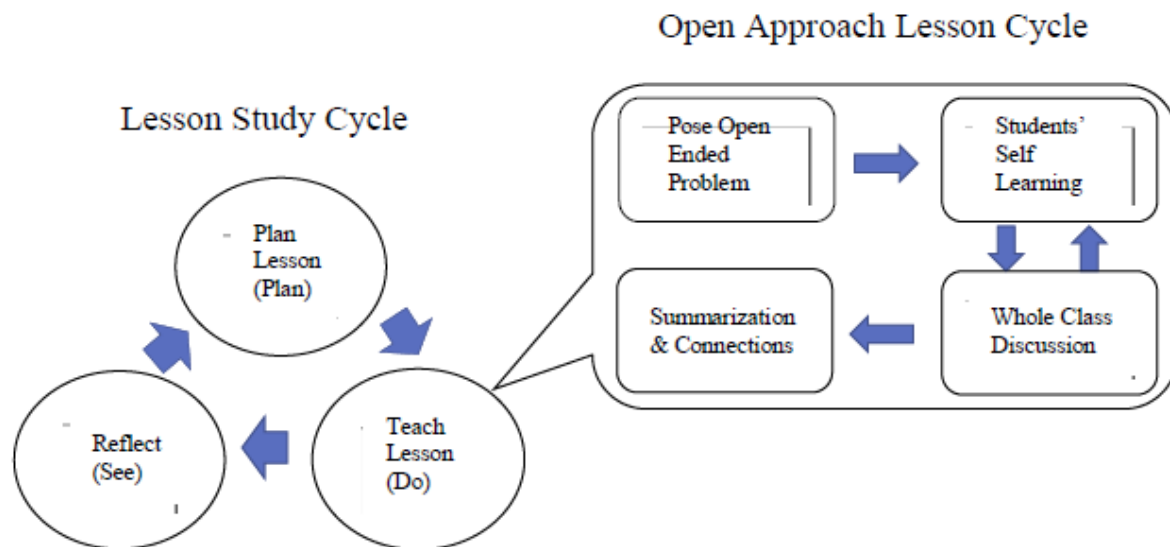
Figure 2. Lesson study with open approach cycle (adapted from M. Inprasitha, 2015).

The use of open-ended mathematics problems allows students to use their own experiences and prior knowledge to brainstorm solutions to these problems using creativity and real-life experiences. This technique eliminates the traditional lecture format in which the teacher gives students problem-solving steps; in this case, the students start solving the problems on their own. They use their own strategy for problem-solving. As students explore solutions, the teacher observes their thinking process and asks questions to help them reveal problem-solving strategies. The goal of this approach focuses on helping students develop and discover mathematics formulas and underlying rules and principles by themselves (Panbanlame et al., 2014).

Lesson Study Implementation in the United States

While Thailand leads the LSOA initiative, the concept of lesson study has transferred to American shores on a limited basis. The U.S. witnessed the introduction of lesson study in the

late 1990s and a decade later over 400 schools practice lesson study in some capacity (Murata, 2011). Although lesson study has sparked interest in the U.S., its implementation reflects early stages of practice. Despite this interest, Murata (2011) claims, "we do not yet have a coherent and shared understanding of how lesson study effectively works in different contexts and models of teacher learning" (p. 1). Murata's statement reminds us of two important realities. First, in order for lesson study to be effective in the U.S., researchers and practitioners must make adjustments and modifications from the Japanese version to meet the needs of American teachers. Secondly, any adjustments should not undermine the foundational elements of lesson study that subtly, but substantially, change the approach. To avoid the second concern, further research should identify key elements that make lesson study unique and fit the culture of the American teacher (Won, 2017).

Fernandez, Cannon, and Chokshi (2003) address the first concern of adapting lesson study for U.S. teachers by claiming American teachers approached the idea of lesson study very differently compared to Japanese teachers. For example, the Japanese teachers used three critical lenses to guide their actions. The student lens focused on understanding student thinking and deliberately engaging with the lesson through the eyes of the student. The curriculum developer lens centered on the sequencing and connections of the lesson, while the researcher lens allowed teachers to ask questions about their instructional techniques and design lessons to explore those questions. The American teachers did not approach lesson study with these lenses, which prevented them from developing rich learning experiences (Fernandez et al., 2003).

In an attempt to more closely replicate the Japanese model in the U.S., Hart and Carriere (2011) used these three lenses to examine the implementation of lesson study in an American elementary school. After providing three days of lesson study PD, the authors discovered

teachers struggled to work together when developing a lesson. The collaborative process proved difficult as the teachers struggled when taking the lead in their own learning or sharing responsibility for determining critical learning goals for third-grade mathematics. According to Hart and Carriere (2011), "the teacher participants had never formally shared pedagogical knowledge, negotiated teaching strategies, and discussed student learning and outcomes with colleagues" (p. 31). Both authors realized that lesson study needed adjusting due to different cultural expectations. The teachers required additional instruction in lesson study because the new approach differed from their previous PD experiences. Because teachers had never engaged in critical discussions about content and pedagogy, the authors chose to expand their influence by becoming more involved in teacher discussions. Hence, the authors included scaffold prompts for the teachers designed to increase the depth of thinking and reflection.

Additionally, the debriefing session increased stress because the teacher who taught the lesson became defensive. Initial defensiveness manifested when the teacher stated:

> A couple of times during the discussion today, I was getting defensive about what was being said, but I realized that everyone was taking responsibility for the lesson and it wasn't about me, it was about the lesson. It was hard, but I think I understand better about the process and what we are trying to do. (Hart & Carriere, 2011, p. 34)

This teacher perceived observer comments as critical of her teaching, thus causing a defensive reaction. This exemplifies a cultural difference between American and Japanese teachers. Japanese teachers understand observer comments reflect how students received a collaboratively planned lesson. As a result, the facilitators had to reinforce that observers evaluated the process of exposing student thinking and meeting the lesson objectives. This demonstrated that American teachers may interpret critical comments as personal and question their ability to teach.

In sum, Hart and Carriere (2011) determined teachers developed a curriculum developer and student lens, which improved over the course of a year, but teachers did not develop a

researcher lens. The teachers began to develop lessons by anticipating student needs as "they began to unpack the mathematics in a problem and ponder about how students would approach the different parts" (Hart & Carriere, 2011, p. 36). Moreover, the teachers refined their curriculum developer lens as they began to focus their discussions on how the lessons helped students' understanding of the concept, which led to discussions on adjusting the lesson or providing specific scaffold techniques. The authors, however, did not find any evidence to support the teachers questioning their instructional practices through a researcher lens by suggesting hypotheses and creating experiments. These results demonstrate the cultural differences between PD culture in Japan and the U.S. Compared to Japanese teachers, the American teachers experienced discomfort when taking the lead in collective lesson planning, receiving feedback, observing others, and challenging the ideas of others. The results of the Hart and Carriere study additionally demonstrated more knowledgeable others can aid in the development and growth of each lens.

Meyer and Wilkerson (2011) conducted a similar study to determine if a small-scale lesson study provided opportunities for participating teachers to improve mathematical content and pedagogy knowledge. Using inductive qualitative analysis, axial coding, and constant comparative analysis, they determined lesson study had the potential to increase teachers' content and pedagogical knowledge if teachers focused on conceptual understanding. Teams focusing on lesson implementation alone generally missed the point of conceptual understanding. Discussions related to anticipating student questions and responses based on content and conceptual understanding allowed teachers to develop a better understanding of connections between their specific topic and the rest of the content. Additionally, when teachers developed

lessons and activities related to real-world situations, the students made better mathematical

connections.

This study emphasized several important features of lesson study critical to teacher

success in the U.S. To illustrate, two groups spent quality time anticipating student questions and

responses focusing on conceptual understanding. The authors explained:

> Again, by having teachers predict students' questions and responses, this element
> encouraged teachers to think in terms of the students, which supports a better
> understanding of their own knowledge of both mathematics and students. One teacher
> even commented, 'Trying to think like the students would think during the lesson made
> me have to look at the lesson as if I was learning it for the first time and even improved
> my own understanding.' (Meyer & Wilkerson, 2011, p. 23)

The teachers who spent a considerable amount of time predicting student questions and

responses created successful lessons. Their predictions proved accurate and suggested this

process deepened the teachers' own conceptual knowledge of the topic. The groups that did not

spend time discussing anticipated student questions and responses, related to conceptual

understanding, missed an opportunity to increase their knowledge of teaching mathematics.

Fidelity

During their study, Meyer and Wilkerson (2011) revealed the importance of fidelity with

the lesson study process. Specifically, the authors reported one group did not follow the lesson

study process because they did not attend instructional sessions. As a result, the authors

emphasized, "Therefore, this group did not necessarily follow the lesson study cycle and this

called into question the fidelity of implementation of lesson study" (Meyer & Wilkerson, 2011,

p. 22). This quote suggested teachers who lacked lesson study instruction followed traditional

patterns of teaching behavior and reverted to previous PD practices, which greatly inhibited their

learning. These findings support Murata's (2011) claim that a lack of fidelity can undermine the

foundational elements of lesson study that subtly, but substantially, change the approach.

Lewis and Perry (2017) addressed fidelity in one of the few quantitative research studies related to lesson study. Their study provided implementation support of a proven instructional strategy related to teaching fractions at a conceptual level. Lewis and Perry used Japanese textbooks, lesson plans, and videos to provide examples of how to teach the fraction lesson effectively. The researchers provided a structure to increase the probability of teachers successfully implementing a specific lesson. A focus on students' thinking and collecting feedback information facilitated the teachers' adaption of the Japanese lesson to meet the conditions of their immediate surroundings. While teacher participation in lesson study deepened their understanding of how to teach a Japanese fractions lesson, from a fidelity standpoint, the authors did not present evidence indicating the teachers would or would not become self-sufficient researchers in the Japanese tradition.

The fraction resource kits provided by Lewis and Perry (2017) included questions designed to provoke discussion among teachers. They reported:

> The resource kit includes prompts to discuss why students answered particular fractions problems incorrectly and what challenges students face in understanding fractions, how different curricula and fraction models might influence student thinking, and what data should be collected during the research lesson to capture students' thinking. (Lewis & Perry, 2017, p. 286)

The prompting ameliorated the common issue of American teachers conducting superficial and shallow discussions. Given the large-scale implementation of this study and the large number of participants, this high level of structure and organization proved effective. The structuring helped ensure the fidelity of implementation not only with the lesson, but it greatly aided in the fidelity of the lesson study process.

Lesson Study Conclusion

In conclusion, lesson study embodies many elements characterizing effective GPD and

MPD practices. Lesson study promotes the use of concrete and practical student activities focusing on relevant problem-solving within the teachers' immediate context and environment. Moreover, lesson study emphasizes the use of sustained collaborative networks that provide on-site and immediate teacher support (Desimone & Garet, 2015).

To further develop these concepts, Takahashi (2015) describes PD as skill development. As individuals develop skill, the process of transfer becomes critical if staff developers expect teachers to implement new learning in their classrooms. Takahashi (2015) states, "One should practice how to incorporate new ideas and procedures in various situations to become comfortable using them in any situation" (p. 52). As a result, Takahashi recommends supporting teachers through PD in two phases. The first phase promotes acquiring a new skill through learning, listening, and seeing. The second phase facilitates the transfer and development of those skills through planning, doing, and reflecting. In many cases, schools provide Phase 1 PD through a variety of approaches that provide teachers with new knowledge and information but do not always provide Phase 2 opportunities. The second phase allows teachers the opportunity to apply new learning in their classroom with their students. Takahashi insists both phases underscore the support needed to help teachers through the process of transfer in order to have a realistic chance of implementation.

Takahashi (2015) has also suggested American teachers have learned to appreciate the collaborative nature of lesson study. Traditionally, in U.S. schools, teachers do not plan lessons together nor do they observe each other's classrooms. The American education culture does not encourage teachers to observe each other because of the stigma attached to administrator evaluations. However, under supportive conditions, such as lesson study, teachers have reported overcoming feeling judged and learn to value what other teachers can offer.

As previously mentioned, the U.S. and Thailand experienced similar issues related to mathematics education. One example includes overcoming the challenge of learning to teach using a constructivist, inquiry-based, approach. As demonstrated by several studies, the process of eliminating a traditional approach in favor of this new method has proven difficult; however, the PD approach of lesson study has delivered promising results in changing teacher instructional behaviors. The use of M. Inprasitha's conceptualization of OA embodies an effective professional learning tool for teachers. By providing space for students to explore their own metacognitive problem-solving strategies, with teacher support, they can create mathematical understanding "by and for themselves" (Isoda, 2015, p. 82). When open approach dovetails into the lesson study cycle, the potential to change how teachers and students interact with mathematics increases dramatically.

Enacting lesson study in the U.S. characterizes both challenges and exciting opportunities to increase student achievement. While exciting, the potential exists for lesson study to lose momentum if a lack of fidelity fails to cultivate lesson study in a constructive manner. Building capacity for American teachers to take advantage of this system must include attention to elements that make lesson study unique in comparison to competing PD approaches. Therefore, to examine the American implementation of LSOA requires more research. The Japanese have cultivated this approach for over 140 years; therefore, asking American teachers to do the same will take time.

<center>Self-Determination Theory</center>

Asking teachers to change their instructional paradigm as a result of PD has proven difficult (Borasi & Fonzi, 2002; Hart & Carriere, 2011; Lam, Cheng, & Choy, 2010; Olson et al., 2014; Won, 2017). A *paradigm* in the realm of instruction refers to a teacher's beliefs about the

nature of knowledge and how their students best acquire that knowledge (Snowman & McCown, 2015). Moreover, if teachers assume a positivist position and believe unambiguous right and wrong answers exist, their beliefs could lead them to prefer teacher-centered instructional practices. Yet, teachers who assume an interpretivist view and understand learning as a process of personal observation, reasoning, and experimentation could promote and use student-centered instructional practices in the classroom. Paradigms deeply rooted in a person's mind, soul, and spirit guide every instructional decision made by teachers. Therefore, asking teachers to change their fundamental beliefs about learning requires great effort and support.

Although the LSOA and Learning Study research demonstrates promising results as an effective form of PD, it does not include a theory of teacher motivation (Kongthip et al., 2012). According to Van Eekelen, Vermunt, and Boshuizen (2006), when teachers are asked to learn and use new instructional initiatives, they must demonstrate a will to learn before engaging in PD. If they do not have this will, the probability of successful implementation will be short-lived at best. Van Eekelen et al. also determined that teachers who agreed with the instructional design demonstrated this will to learn because they believed it would help them in the classroom with their students. Additionally, Shulman and Shulman (2004) argued that teacher motivation exemplifies one of the most critical components of successful PD. In order for teachers to consider shifting their teaching paradigms, they not only need quality approaches to PD, they also need to have the motivation to do so. To address the motivational component absent in LSOA, I describe self-determination theory (SDT) and apply its use to LSOA. Specifically, I examine how the three components of SDT relate to the LSOA model, as well as how SDT may motivate teachers to engage in LSOA.

Deci and Ryan (2008) categorize human motivation as either proactive or passive.

Moreover, they assert a person's social condition and environmental situation often contributes to this dichotomy. Therefore, SDT seeks to understand social and contextual factors that contribute to positive or negative motivational development. Three factors or psychological needs were found to increase human intrinsic motivation and well-being: (a) competence, (b) autonomy, and (b) relatedness (Deci, Vallerand, Pelletier, & Ryan, 1991). Deci et al. define *competence* as feeling successful in completing a task. Satisfying the need for competence includes effectance and epistemic motives (Ryan & Deci, 2017). *Effectance* refers to one's ability to intentionally cause desirable outcomes from a causal perspective and *epistemic* refers to one's desire to obtain personally meaningful knowledge. Additionally, they describe *autonomy* as the perceived feelings of having choice when engaging in a task. Autonomy reflects *locus of causality* (as situated in SDT), which describes an individual's perception of complying with a request/regulation due to their own volition or willingness to do so. Lastly, *relatedness* characterizes feeling supported by others in a safe and nurturing environment. When individuals experience these psychological needs at satisfactory levels, they become more motivated; however, when individuals' needs are not adequately met, motivation and psychological well-being can decrease.

According to Markland et al. (2014), consumers of SDT research often interpret competence and Bandura's (1986) notion of self-efficacy interchangeably. To clarify, Ryan and Deci (2017) derived their perspective of competence based on the writings of White's (1959) seminal work on effectance motivation. White claimed that competence reflects an isolated construct of motivation that does not result from other human drives or desires. From this perspective, competence characterizes a nonderivative need to influence one's environment and gain satisfaction from producing results within one's immediate surroundings. Important to note,

competence relates to meaningful tasks; therefore, performing mundane or meaningless tasks does not contribute to meeting this need. Thus, the concept of *competence* is related to the intrinsic desire to overcome personal challenges that lead to well-being and psychological health.

In contrast, Bandura's (1986) notion of self-efficacy centers on believing in one's capacity to perform a task. In other words, self-efficacy reflects the level of confidence that influences an individual's task persistence. This confidence includes "trivial behaviors that comprise only a part of a larger, goal directed set, or sequence of behavior" (Markland et al., 2014, p. 4). This discrepancy describes a noteworthy distinction between the two constructs; competence involves on personally meaningful challenges to engender satisfaction, while self-efficacy focuses on confidence without considering the level of personal meaning.

By extension, the confluence of these three psychological needs enhance and perpetuate intrinsic motivation and overall well-being. While critical to SDT, these psychological needs account for half of the theory. To fully comprehend SDT as a grand theory of motivation, understanding its individual components and how they interact remain critical. Two subtheories combine to form SDT, which include cognitive evaluation theory and organismic integration theory (Ryan & Deci, 2017).

Cognitive Evaluation Theory

Cognitive evaluation theory describes intrinsic motivation and explains the factors that maintain and support this form of motivation. Intrinsic motivation refers to "doing an activity for the inherent satisfaction of the activity itself" (Ryan & Deci, 2000, p. 71). Deci and Ryan (1985) made it clear that SDT does not concern itself with the creation of intrinsic motivation because they believed intrinsic motivation naturally occurs in humans. Instead, they focused on researching conditions that promoted and strengthened intrinsic motivation.

The initial findings of Deci and Ryan (2008) suggested that competence increased feelings of intrinsic motivation; however, further research suggested that in order for substantial increases in intrinsic motivation to take place, more than competence alone was needed. Individuals also needed to feel a sense of *autonomy*. Ryan and Deci (2000) supported this claim by insisting, "choice, acknowledgment of feelings, and opportunities for self-direction were found to enhance intrinsic motivation because they allow people a greater feeling of autonomy" (p. 70). When feelings of competence conjoin with feelings of autonomy, intrinsic motivation substantially increases.

In addition to realizing the influence that competence and autonomy had on intrinsic motivation, Deci and Ryan (1985) characterized relatedness as the third imperative factor. The concept of *relatedness* promotes the importance of having a relationship with others and building trust in safe environments. Deci and Ryan noted that traits of intrinsic motivation became apparent in infancy and early childhood. Children who had close and supportive relationships with their parents exhibited stronger intrinsic qualities. The tendency to demonstrate higher levels of intrinsic motivation throughout a person's lifetime increased when they grew up in supportive and safe environments. Individuals who experienced caring environments and authentically belonged to a group felt higher levels of relatedness. Therefore, feelings of relatedness and belonging within in a safe environment, along with competence and autonomy, enable individuals to feel high levels of intrinsic motivation (Gagné & Deci, 2005).

Ryan and Deci (2000) explained that people might not experience intrinsic motivation in many of their everyday life experiences. They emphasized, that as children grew into adults, the social expectations of their activities and responsibilities might remove many opportunities to naturally engage in intrinsically motivated activities. The authors claimed, however, that willful

motivation did not cease to exist during adulthood. While this seems to imply a definitive end of intrinsic motivation and the beginning of an extended period of extrinsic motivation, SDT offers a deeper explanation. Ryan and Deci addressed this deeper explanation by describing the second subtheory known as organismic integration theory.

Organismic Integration Theory

Organismic integration theory refers specifically to levels of motivation that vary from controlling to autonomous. Ryan and Deci (2000) defined extrinsic motivation as performing an activity "in order to attain some separable outcome" (p. 71). Deci and Ryan reported many people naturally associate extrinsic behavior with punishments and rewards, but this association does not express complete accuracy. After conducting a series of experiments, they concluded extrinsic behaviors and motivation can exist on a wide-ranging continuum. To illustrate, athletes who complete extra workouts generally understand the purpose of the extra work enhances performance. The athlete who appreciates the value of this extra work expresses extrinsic motivation, although they perceive they have a choice in the matter and personally affirm the practice. This extrinsically motivated athlete exhibits a high level of relative autonomy (i.e., free will, choice). And yet, a different athlete participating in the same extra workout may exhibit low levels of autonomy if they do not see the value and participate based on the coach's request. While both athletes demonstrate extrinsic motivation to achieve a specific outcome, they demonstrate very different levels of perceived autonomy and value.

The above example illustrates how different individuals, when participating in identical activities, can demonstrate varying perceptions of locus of causality (i.e., volition or willingness to complete a task). The athlete example demonstrates how extrinsic motivation can include varying degrees of internalization and integration. In this context, *internalization* refers to the

level of acceptance or value of a request/requirement; while *integration* refers to a deeper level of acceptance, which includes personal ownership and an internal locus of causality. Both terms indicate a positive perception of autonomy. Ryan and Deci (2000) visually represented the concept of varying levels of extrinsic motivation and internalization/integration on their self-determination continuum.

Ryan and Deci (2000) divided the continuum into three main categories of motivation ranging from amotivation to intrinsic motivation. They define the term *amotivation* as a complete lack of motivation or just enough effort to perfunctorily perform a task at minimal levels. Amotivation reflects a significant lack of effort resulting from (a) an absence of recognizing any inherent value, (b) feeling insecure, or (c) lacking confidence in their ability to complete the task. This additionally includes believing the desired outcome represents an impossible task. The authors subdivided extrinsic motivation into four levels ranging from external to integrated, with intrinsic motivation completing the continuum. Intrinsic motivation represents (a) complete autonomy, (b) high value, and (c) satisfaction based on interest and enjoyment; Deci and Ryan (2008) consider intrinsic motivation to be the pinnacle of self-determined behavior and motivation (see Figure 3).
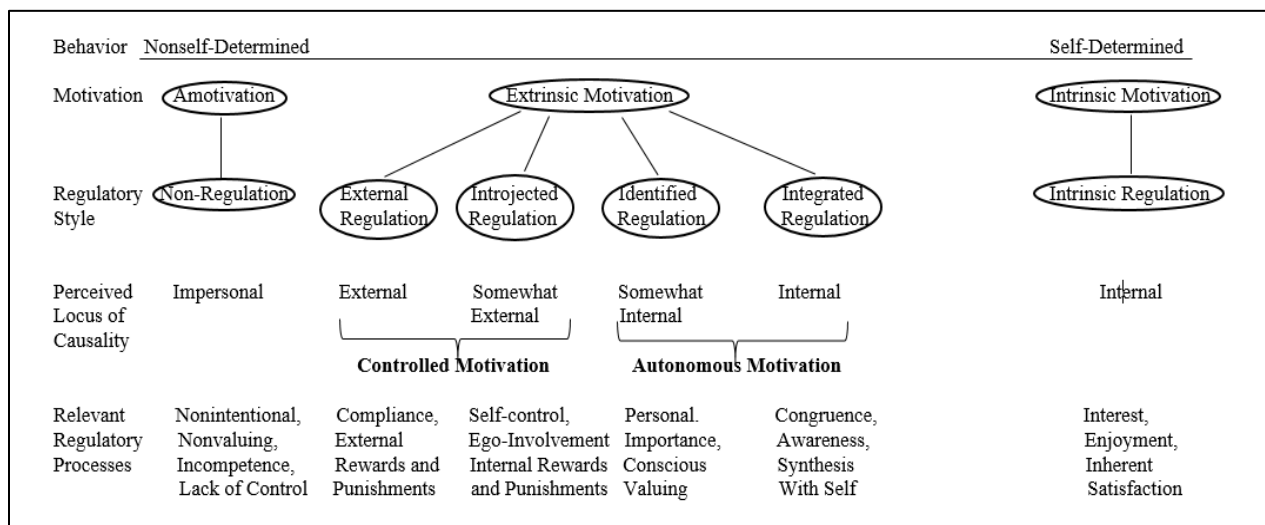
Figure 3. The self-determination continuum (adapted from Ryan & Deci, 2000).

The subdivided categories of extrinsic motivation typify important considerations in understanding the organismic integration theory. Externally regulated motivation characterizes a strong external locus of causality (Deci & Ryan, 1985). *External regulation* represents the perception of complying with a request/requirement imposed by an external figure of authority that does not originate from within the individual (Deci & Ryan, 2008). In this case, the individual sees little value in the request and compliance depends on behavioral stimuli. Skinner's (1953) conception of operant conditioning applies to individuals at this level, as reinforcements and punishments either strengthen or weaken behaviors. For instance, some school districts require teachers to participate in PD classes over the summer in exchange for mandatory compensation days during the school year. Teachers who comply demonstrate external regulation if they see little value in the PD and only attend to avoid punishment.

Introjected regulation occupies the next level of the continuum, moving from left to right, and represents a somewhat external locus of causality because an individual does not completely accept the task as one's own (Deci & Ryan, 1985). The pressure to comply with the request/requirement centers on escape. In other words, individuals act to avoid feelings of guilt, fear, anxiety, or the loss of self-esteem. They act to maintain feelings of worthiness and dignity, and in some cases, comply due to pride or a competition-based ego (Deci & Ryan, 2008). For example, a teacher might participate in professional learning communities because of the involvement of other teachers. Their involvement lacks authentic value if their incentive to participate exists due to feelings of guilt when other team members assume a majority of the workload. Their motivation is based on introjected regulation and lacks depth and commitment.

During the *identified regulation* level of motivation, the locus of causality begins to shift as individuals start internalizing requests/requirements as their own (Deci & Ryan, 1985). In this

scenario, the individual becomes compliant based on the newly perceived value of the request/requirement and it becomes personally important to them. Moreover, they take more personal responsibility in managing the requirements of the task. Deci and Ryan (2008) term this motivation as extrinsic because the individual assumes a positive outcome in goal achievement. The person's performance in the activity does not reflect motivation due to enjoyment or interest (Deci & Ryan, 2008). When teachers begin the process of seeking professional learning opportunities on their own without prompting from administration or the district, they exemplify identified regulation.

Deci et al. (1991) define the highest level of extrinsic motivation as *integrated regulatio*n, which shares many similarities with intrinsic motivation. The significant difference between the two centers on the location of the reward. For example, individuals may feel intrinsically motivated due to the reward of joy and satisfaction. Conversely, at the integrated level individuals may feel extrinsically motivated due to a reward they receive as an outcome of the task, such as a paycheck or a high performance evaluation. At the integrated level, the locus of causality remains internal as the individual assumes full ownership of the request/requirement and integrates the task as one's own based on volition. The value of the request aligns with their core values and beliefs at a high level. Generally, this level of regulation occurs during adult stages of development (Deci et al., 1991). A teacher who engages in PD on their own time to accomplish classroom teaching goals they set for themselves demonstrates integrated regulation, as their behavior and choices indicate a high level of ownership in self-improvement.

By combining the cognitive evaluation theory with the organismic integration theory, Deci and Ryan (1985) created the grand theory of SDT. By understanding both subtheories, autonomy and internalization essentially create self-determination within an individual; thus,

driving their motivation. A person becomes more motivated when they have choice/control and highly value something, even when they work toward extrinsic rewards. Conversely, when an individual loses autonomy, volition diminishes and the feeling of being controlled increases; thus, value perceptions lessens, which causes a reduction of motivational behaviors. Deci and Ryan (2008) remind us the goal of SDT centers on intentionally creating environmental and social conditions that promote (a) competence, (b) relatedness, and (c) autonomy. Improving these psychological needs can shift or promote a more internalized type of motivation because individuals will perform at higher levels as a result. Motivation associated with higher levels of autonomy and internalization for both children and adults results in (a) enhanced interest, (b) persistence, (c) excitement, (d) creativity, and (e) confidence when engaging in tasks (Deci & Ryan, 2008).

<p style="text-align:center">Self-Determination Theory Applied to Lesson Study with Open Approach</p>

The three psychological needs of (a) competence, (b) autonomy, and (c) relatedness connect well to the basic tenets of LSOA, which creates many opportunities for teachers to feel autonomously motivated. The main goal of LSOA focuses on increasing teacher competence by providing sustained support and resources imbedded into the teachers' direct environment. Additionally, LSOA specifically helps teachers meet the expectation of student-centered instructional approaches, which align with the ubiquitous high-level standards for student learning. In sum, the fundamental aim of LSOA provides teachers with opportunities to increase their competence.

The structure of LSOA focuses on allowing teachers to choose the topic of their research and asks them to develop collaborative research lessons. Therefore, autonomous decision-making remains a fundamental and critical aspect of the LSOA process. Won (2017) exemplified

the positive results of autonomous decision-making when teachers expressed concern that students' mathematical reasoning based on rote procedural steps greatly reduced student conceptual understanding. As a result, all four teachers decided the lack of conceptual understanding directed the focus of their lesson study. Making choices gave them the ability to select the content of their collaborative study, which, consequently, increased their level of participation and commitment.

The third psychological need of relatedness directly relates to LSOA because of the high nature of collaboration involved in the process. Every aspect of LSOA involves working in collaboration with other teachers. This includes (a) collaborative lesson planning, (b) observation of the lesson, and (c) reflection/revision of the lesson. According to Won (2017), teachers who participated in lesson study valued seeing the perspectives of others, which helped them see teaching from a different lens. Having to explain their thinking among other teachers stretched their own thinking about pedagogy and tested their values and baselines. The teachers reported that trusting one another allowed an honest exchange of ideas and suggestions. Additionally, when asking teachers to shift paradigmatic beliefs, working with others proved beneficial to the change process. A teacher's participation in collective sense-making, as it related to shifts in paradigms, helped them understand and follow the norms agreed upon by the group. Moreover, teachers who observed live lessons and then discussed student thinking, reported collaboration improved their sense-making, which also supported the change process. In other words, teachers participating in LSOA had many opportunities to participate in group environments. As long as interpersonal relationships included safe and accepting interactions, teachers experienced the benefits of engaging in relatedness-type environments.

A powerful concept associated with SDT highlights internalization and suggests that extrinsic motivation can move to the intrinsic side of the continuum over time. Deci et al. (1991) reported individuals who originally complied with tasks due to external pressure could, over time, internalize the activity. Furthermore, if an individual determined the request/requirement proved useful in their social environment by helping them achieve goals, they began to transform their regulatory orientation.

The process of internalization occurs as the individual understands and appreciates the value of the activity and incorporates it into their base values and beliefs. Once this process of internalization occurs, the individual assumes ownership of the activity and makes it their own, moving their motivational behavior closer to intrinsic characteristics.

Moving up the continuum toward higher levels of internalized motivation has powerful implications because teachers who start the LSOA process from an external or introjected regulation can move toward identified or integrated forms of regulation when they experience positive results. The process of gaining competence from LSOA may move a teacher's motivation up the continuum, causing them to become more intrinsically motivated to continue their participation. Although Lewis and Perry (2017) did not approach their research of lesson study from a motivational standpoint, they determined lesson study did increase the competence of teachers. Both teacher and student growth reflected statistical significance and meaningful effect sizes. Once the lesson study ended, teachers continued to ask for more lessons and preferred to continue the lesson study process. This finding suggests increased competence led to higher levels of intrinsic-like motivation.

The steps involved in the LSOA process provide opportunities for teachers to experience the three psychological needs of SDT. Additionally, the emphases on collaborative interactions

and dialogue have the potential to persuade teachers of the value of their work, allowing them to move up the continuum if they initially resist the new learning initiative. By providing teachers with a high level of choice-making, LSOA encourages autonomy in every phase of the process. This autonomy represents a major component of SDT, since intrinsic-like motivational behaviors depend on a person's perception of locus of causality.

Deci and Ryan (1985) make a distinction between autonomous and controlled motivation and describe how each type influences human behavior. Individuals who internalize requirements to perform a task as controlled (a) demonstrate low incentive, (b) perform at perfunctory levels, and (c) lack ownership in the performance of their tasks. Conversely, individuals who internalize requests/requirements as autonomous assume (a) personal ownership of the task, (b) perform at high levels, and (c) maintain persistence when faced with frustration. Hence, autonomously motivated individuals demonstrate higher levels of capability when addressing complex issues that involve creativity and problem-solving (Deci & Ryan, 1985). The fundamental goal of LSOA revolves around problem-solving (i.e., researching and developing theory), so promoting environmental factors to enhance intrinsic-like behaviors increases the potential for teachers to experience success when using the LSOA model.

In summary, the components of LSOA align with the three psychological needs of (a) competence, (b) autonomy, and (c) relatedness. Proper implementation of this PD approach may meet the basic needs of teachers and set the stage for promoting autonomous motivation. As stated by Deci and Ryan (2008), "Research has shown that autonomous motivation predicts persistence and adherence and is advantageous for effective performance, especially on complex or heuristic tasks that involve deep information processing or creativity" (p. 14). Because the

LSOA process resembles a heuristic model, using SDT to motivate teachers illustrates the likelihood of a good fit.

Environmental Conditions Supporting Self-Determination Theory Internalization

The three components of SDT align well with the tenets of LSOA educational leaders can promote environmental factors that enhance autonomous teacher motivation. For individuals to achieve higher levels of motivation, they need to internalize and integrate the request/requirements as their own. Therefore, authority figures may intentionally provide or create social and environmental conditions that increase the three psychological needs to encourage higher levels of motivation. The following discussion reviews research demonstrating examples of environmental conditions that may support each of the psychological needs in SDT.

Competence

Environmental conditions supporting teacher internalization of competence include opportunities to model and observe. According to Gorozidis and Papaioannou (2014), "The teachers' need for competence can be satisfied through vicarious experiences, by watching innovative teaching models . . . and by verbal persuasion in the form of feedback, encouragement and guidance" (p. 9). This quote supports the claim that teachers need to observe classrooms to view demonstration lessons, so that they gain a holistic understanding of the process. Gorozidis and Papaioannou describe a process of learning that asks teachers to replicate what they observed with their students, and the last phase includes inviting a more knowledgeable other to observe and provide feedback. This process occurs in the teacher's classroom to promote embedded learning in an authentic environment. The learning process described by Gorozidis and Papaioannou certainly supports the fundamental elements of LSOA, which increase teacher internalization and competence.

In a study conducted by Lam et al., (2010), the researchers conceptualized competence as the school's ability to effectively facilitate teacher learning in relation to new reforms. They determined teachers had higher levels of internalization when their workload did not increase and they had time during the day to plan their instruction. Additionally, teachers needed a reasonable timeline of implementation, so they had the time and space to feel confident in their new learning. Lam et al. similarly determined the successful implementation of new instructional initiatives generally occurred during the second year with the inclusion of additional support. To put this in perspective for policymakers, teachers who receive less than 14 hours of focused PD instruction will not make an impact; however, PD over this threshold can translate to increases in student achievement. Additionally, 50 hours of instruction can lead to a 21% increase in student achievement (Gorozidis & Papaioannou, 2014).

Autonomy

When referring to autonomy, Gorozidis and Papaioannou (2014) reported environmental conditions supporting teacher internalization of autonomy include (a) choice, (b) input, and (c) flexibility based on professional judgement. In other words, teachers need the ability and freedom to customize instructional initiatives to meet the needs of their specific students in their unique environments according to their preferences. Teachers need this flexibility and choice and, thus, might have input into their PD instruction in order to individualize it to meet their needs. To further illustrate this point, Lam et al. (2010) noted teachers wanted to provide input on the "direction and contents" (p. 14) of their new project-based learning initiative, in addition to having flexibility in how to supervise their students. Teachers also appreciated administrators soliciting their input throughout the process and making adjustments based on their input. Lam et

al. concluded, teachers who felt pressured to comply with new curriculum from a top-down approach exhibited much less intrinsic motivation.

Principal leadership style reflects a social factor that greatly affects autonomy. Consider Eyal and Roth (2011), who investigated the relationship between leadership style and teacher motivation. They evaluated teacher reaction to transformational and transactional leadership styles. Eyal and Roth asserted *transformational* leaders included principals who mobilized and motivated followers to exceed their normal behaviors. Transformational principals accomplished this by attending to the needs of followers and promoting and ascribing to a clear and common vision. By soliciting focused energy on a particular outcome, transformational leaders acquired commitment from organizational members to complete a common goal (Bass & Avolio, 1994). Principals facilitated this process by modeling expected behaviors and encouraging creative problem-solving and empowering teachers, which promoted a social environment in which teachers became autonomously motivated. This type of leadership reduced teacher burnout and increased (a) performance, (b) self-actualization, and (c) psychological well-being (Fernet, Guay, Senécal, & Austin, 2012).

Conversely, Eyal and Roth (2011) described *transactional* leaders as maintaining efficiency by adhering to procedural processes and organizational policies. These principals focused on adhering to predetermined procedures and monitored their faculty and staff for compliance. Eyal and Roth suggested principals who employed the use of transactional leadership techniques created social environments that demotivated the faculty and staff. Teachers who worked for transactional principals perceived their environment as nonautonomous. The teachers felt controlled, resulting in higher levels of teacher burnout/turnover and lower levels of job satisfaction.

These results about leadership styles of principals from Eyal and Roth (2011) suggest that the social environment created by school administrators can greatly affect teacher motivation. Eyal and Roth (2011) concluded by stating, "Thus it seems that by providing teachers with an autonomy-supportive working environment, principals can help teachers construct the meaning of their mission and help them make sense of their role and the educational sphere" (p. 268). Principals might, therefore, work on creating environmental conditions that promote (a) teacher learning, (b) growth, and (c) fulfilment from a PD viewpoint.

Relatedness

Deci and Ryan (2008) believed environmental conditions supporting teacher internalization of relatedness included feeling supported in a safe and encouraging group of peers. Creating a supportive interpersonal climate helps individuals reach higher levels of autonomous regulation. Individuals need to feel supported and safe in their environmental circumstances to do this. Conversely, when the interpersonal climate promotes internal competition, pressure, and action due to reinforcements or punishments, they operate from an external or introjected position (Deci & Ryan, 2008). As a result, administrators need to monitor and facilitate positive interpersonal interactions among collaborative teams. Furthermore, if teachers report interpersonal issues, administrators could take action to solve the issue due to the critical nature of relatedness in promoting autonomous motivation.

The interpersonal approach taken by an authority figure can influence how an individual accepts and interprets requests or rewards (Deci & Ryan, 2008). For example, if a principal delivers a positive message using controlling language such as *you must* or *you will*, with a directive-style demeanor, the teacher may perceive the feedback as controlling. Controlling language can lead to feelings of lost autonomy and, in turn, a loss of intrinsic motivation—even

if the communication embodied positive intent. And yet, if administrators use noncontrolling language with an encouraging demeanor to deliver critical information, recipients of the communication can feel autonomously motivated.

In sum, how principals deliver information remains critically important in determining the perception of control. An authority figure could intentionally send noncontrolling messages when communicating request/requirements to others. Deci et al. (1991) reinforced this sentiment when they argued, "Being controlled by an external contingency tends to diminish an individual's sense of autonomy. It fosters an external perceived locus of causality and thus decreases intrinsic motivation and/or forestalls internalization" (p. 335). Creating contextual factors increasing motivation and internalization by using noncontrolling interpersonal interactions identify a critical starting point for administrators.

Teacher Reaction to Environmental Pressure

While figures of authority may mediate social factors affecting motivation, a teacher's environment similarly influences their classroom behaviors. While it might be nice to assume all teachers could easily support autonomy-supportive classrooms, the reality reflects many challenges. For example, teachers subjected to the pressures of high-stakes accountability via standardized testing generally revert to controlling approaches of classroom management and instructional techniques (Deci et al., 1991). Au (2007) exemplified this effect when he determined teachers generally reacted to testing pressure by (a) narrowing the curriculum to focus on tested material, (b) presenting lessons in isolation, and (c) returning to teacher-centered classroom management strategies. In addition, Au's findings revealed teachers who used student-centered instructional strategies reverted to teacher-centered instruction when they felt pressured to increase standardized assessment scores.

Deci et al. (1991) similarly discussed a study examining the outcome of pressure placed on teachers. Administrators placed testing pressure on a sample of teachers through constant reminders of the importance of successful test results, while a second sample did not receive any pressure. The results indicated nonpressured teachers maintained autonomy-supportive classrooms, while the pressured teachers increased controlling-classroom behaviors at a substantially higher rate. Pressured teachers had a higher propensity to abandon student-centered autonomy-producing teaching styles in favor of teacher-centered controlling approaches. This undoubtedly highlights the acme of irony as adding pressure creates the opposite effect from a motivational perspective (Soenens, Sierens, Vansteenkiste, Dochy, & Goossens, 2012). When autonomous motivation declines, the students' understanding of conceptual ideas and academic well-being diminish. Therefore, administrators should consider avoiding the social condition of pressuring teachers, both directly and implicitly, so they do not diminish a teacher's competence and autonomy, which reduces autonomy-supportive classroom behaviors.

Self-Determination Theory Conclusion

When compared to other motivational theories, SDT capitalizes on the distinction of perceived locus of causality. SDT specifically focuses on self-determined or autonomous motivations versus controlled motivation. Deci et al. (1991) affirms this claim when they state, "When a behavior is self-determined, the regulatory process is choice, but when it is controlled, the regulatory process is compliance (or in some cases defiance)" (p. 326). In similar fashion, the regulatory process highlights how an individual responds to or accepts a request/requirement. The choice to comply, based on valuing or believing in the request, reflects self-determination because the choice to comply resides in the individual. Conversely, if an individual does not value the request/requirement, their compliance occurs because they feel forced by a figure of

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authority, which illustrates a controlled type of motivation. An individual who perceives greater levels of self-determination will have higher levels of motivation. Therefore, understanding how one can deliberately create contextual and social factors promoting value and self-determination in teacher PD enhances probable success in improving teacher and student learning outcomes.

In sum, the process of changing a teacher's instructional paradigm demonstrates a formidable challenge; however, LSOA offers encouraging possibilities as a professional learning tool because it addresses:

- Changing teacher paradigms

- Increasing student achievement

- Meeting the demands of high-level standards

- Increasing mathematical conceptual understanding

- Promoting a continuous cycle of teacher improvement

Although LSOA research has provided promising results (Chaovasetthakul et al., 2017; Jaijan & Loipha, 2012; Jaijan & Suttiamporn, 2013; Kongthip et al., 2012; Panbanlame et al., 2014; Saengpun & Inprasitha, 2012), it does not include a model of teacher motivation. To put it succinctly, if teachers resist new learning due to a lack of motivation, then the best of approaches will fall into the category of failed attempts (and perhaps only fragments of discarded remains will persevere), thus wasting time, energy, and resources—not to mention a failure to increase student achievement. To avoid this all-too-common fate (Guskey, 2002), applying SDT may create the social environment needed to facilitate LSOA by encouraging autonomously motivated teachers. The central tenets of LSOA dovetail nicely with the three psychological needs of teachers outlined in SDT; however, creating supportive factors with intentionality should reflect deliberate actions. Therefore, individuals selecting and facilitating PD might consider how to include and continuously promote competence, autonomy, and relatedness into a

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comprehensive package. Taken together, LSOA and SDT may have the potential to positively support teachers, thus leading to increases in student achievement.

<p style="text-align:center">Teacher Motivation</p>

The literature review of teacher motivation examines the origin of a teacher's will to engage in PD because understanding the emotion that drives behavior can inform how a teacher experiences new learning. Teacher motivation can dictate the levels of (a) teacher participation, (b) sustainment, and (c) commitment in relation to PD efforts (Hargreaves, 2005). Based on a critical analysis of empirical evidence, Korthagen (2017) has suggested PD approaches that solely focus on improving teacher knowledge often assume that new learning becomes the source of teacher enactment. However, Korthagen argues new learning alone will not necessarily prompt a teacher to enact a practice or implement new pedagogy in the classroom. In contrast, he suggests the sources influencing a teacher's behavior occur due to "the result of a complex mix of cognitive, affective, and motivational sources in the teacher, which remain partly implicit [unconscious] and are not often reflected on" (Korthagen, 2017, p. 390). In other words, teacher enactment occurs as a result of feelings. These feelings include happiness, fulfillment, enjoyment, and approval, as well as anxiety, annoyance, and irritation. These feelings, according to Korthagen, often become the source of teacher behavior as well as their thinking. Therefore, Korthagen asserts teacher learning can no longer focus on cognitive factors alone and coined the term inconvenient truth to embody this need. Korthagen claimed staff developers might consider the emotional and motivational needs of teachers when asking them to learn and implement new instructional strategies.

In an empirical study, Hargreaves (2005) supported the notion that emotional factors contribute to teacher participation in PD by insisting attention to emotional needs underpins the

teacher change process. He argued educational legislation largely ignored the emotional dimension of educational reform and policymakers pay no attention to emotional needs when drafting policy. This ubiquitous dismissive attitude hinders the advancement of effective reform efforts and, until this changes, new efforts to reform student achievement at scale will continue to fail or effect superficial advances at best.

Hargreaves (2005) defended the use of emotions at the classroom level by claiming teachers created impactful instructional strategies by engendering curiosity and infusing passion, excitement, risk taking, and ardent discussions in the classroom. Hargreaves (2005) stated, "Good teachers are passionate about ideas, learning and their relationships with students" (p. 279), while teachers who lack emotions perfunctorily follow procedural steps when instructing students and struggle to make "practical judgments of human value" (Hargreaves, 2005, p. 280). Making good judgements becomes difficult in the absence of emotional connections with students; therefore, unemotional teachers may exhibit dysfunctional or less effective behaviors in comparison to emotionally engaged teachers.

Hargreaves (2005) has suggested teachers make decisions based on the potential positive benefits to their students. Hence, when deciding to incorporate an instructional change with their students, teachers begin the process by analyzing if and how their students will benefit. When teachers believe new learning will benefit their students, motivation increases because of the emotional relationships they have with their students. Hargreaves (2005) emphasized:

> Teachers' emotional connections to students, and the social and emotional goals they wanted to achieve as they taught those students, shaped and influenced almost everything they did, along with how they responded to changes that affected what they did. Teachers wanted to become better so they could help their students. The emotional bond teachers had with their students was central to how they taught them, how they evaluated them, what kinds of curriculum they planned and selected for them, and what kinds of organizational structures they adopted as a context for teaching them. (p. 286)

This suggests teachers become motivated by their feelings to create positive and effective learning experiences for their students. Making decisions that best supports student learning meets the emotional needs of students and their teachers receive feelings of satisfaction and a sense of accomplishment (Hargreaves, 2005).

Other researchers agree with Hargreaves (2005) when analyzing emotional factors that initiate behaviors related to implementing instructional changes. De Ruyter and Kole (2010) made the theoretical argument that teachers act based on the best interest of their students, even if students do not achieve their expectations to the highest degree possible. De Ruyter and Kole have suggested teachers want their students to feel successful, independent, and fulfilled; therefore, obtaining these goals drive their professional decisions. To further support their claim, they conducted a research study and concluded teachers prioritized emotional connections with their students over instructional strategies. For example, teachers wanted their students to feel valued and develop meaningful behaviors like honesty, courage, open-mindedness, and problem-solving skills. This illustration supports the claim that teachers make decisions and enact instruction based on emotion.

Guskey (2002) has suggested teachers engage with PD to "expand their knowledge and skills, contribute to their growth, and enhance their effectiveness with students" (p. 382). He stressed the desire to benefit students contributed significantly to a teacher's level of commitment when participating in PD efforts. Harootunian and Yarger (1980) support Guskey's claim when they reported, "regardless of teaching level, most teachers define their success in terms of their pupils' behaviors and activities, rather than in terms of themselves or other criteria" (p. 4). This evidence suggests actions leading to student benefits reflect a primary source of teacher enactment based on emotions. These examples support the claim that teachers

make many decisions and enact classroom changes based on their emotions related to student support. Therefore, PD approaches could consider not only the cognitive aspect, but may well consider promoting how new learning could help teachers meet their emotionally based student goals.

Motivating Students Can Motivate Teachers

Can teachers increase their level of motivation and overall job satisfaction when they successfully motivate their students? Martin and Dowson (2009) addressed this question based on their theoretical argument that connectedness on a personal and emotional level between students and their teachers can increase student (a) motivation, (b) engagement, and (c) achievement. They suggested the same power of relatedness could motivate teachers as well. They stated, "There are many features of effective leadership that have parallels with motivation and achievement theories . . ." (Martin & Dowson, 2009, p. 350). For example, teachers can become motivated by relational features, such as "emotional and professional support of staff, mutual respect between staff and the executive [principal], connectedness to the student body, interest in and involvement with parents, and link to the community and industry" (Martin & Dowson, 2009, p. 351). The authors maintained intentional classroom strategies, designed to promote interpersonal relationships, contributed to student classroom (a) motivation, (b) engagement, and (c) achievement. As a result, similar techniques and interpersonal relationships can also motivate teachers to the point they increase their own (a) motivation, (b) engagement, and (c) achievement to participate and maintain learning gained from effective PD experiences (Cooper, 2014).

To further this point, Cheon, Reeve, Ho-Yu, and Jang (2014) studied the effects of teachers trained to use autonomy-supportive motivation strategies after participating in an

Autonomous-Supportive Intervention Program (ASIP). To clarify, autonomy-supportive classrooms (based on SDT) focus on meeting the emotional needs of students by addressing (a) successful task completion, (b) competence, (c) volitional task involvement, (d) autonomy, (d) feeling a sense of belonging, and (e) relatedness. Students feel competence when the teacher explains the rationale for learning activities and provides meaningful feedback, which increase a student's sense of accomplishment. Students feel autonomy when the teacher provides opportunities for student choice and uses noncontrolling language. Lastly, students obtain relatedness needs when the teacher seeks the perspectives of students (Jang, Reeve, & Deci, 2010). The combined use of meeting the three psychological needs in the classroom may cause students to feel autonomously motivated.

Students feel autonomous motivation when they perceive their actions originate from their own volition and derive some enjoyment from completing the task. They do not feel a high level of pressure to perform due to their own willingness to complete the task. In contrast, control describes the antithesis of autonomous motivation. Controlling teacher behaviors do not consider student perspectives and prefer to communicate their own ideas without consideration of other's points of view. They use language to convey authoritarian management and pressure students into compliance. Controlling teacher behaviors cause students to perceive their own actions as caused by the authority of others, which reduces the amount of enjoyment they feel when completing the task. This, consequently, lessens student motivation to engage in the learning activities (Cheon & Reeve, 2015). By giving students more ownership and decision-making opportunities in a safe and supportive environment, students become more intrinsically motivated to become engaged in their learning. Cheon, Reeve, Lee, and Lee (2018) argue teachers who shift away from a controlling management style to an autonomy-supportive style

show gains in (a) student engagement, (b) conceptual understanding, (c) academic achievement, and (d) overall well-being.

Cheon et al. (2014) sought to understand how teachers would benefit from providing students with autonomous-supportive motivation strategies in their classrooms. After the study, they reported students with teachers using autonomous-motivating behaviors demonstrated higher levels of (a) motivation, (b) engagement, and (c) achievement. These students had more intrinsic motivational qualities when compared to students with teachers who used controlling forms of motivating behaviors like (a) rewards, (b) punishments, (c) deadlines, and (d) regulating language. As a result, ASIP-educated teachers experienced (a) higher levels of satisfaction, (b) autonomous motivation, (c) focus on intrinsic goals, (d) teacher efficacy, and (e) vitality during teaching and job satisfaction when compared to controlling teachers. ASIP teachers also experienced less emotional/physical exhaustion when compared to controlling teachers.

Researchers also examined the ASIP classroom effects on teachers. Cheon et al. (2014) stated, "Psychological need satisfaction fully mediates and explains the positive effect that ASIP has on students' positive course outcomes, such as engagement, achievement, and well-being" (p. 343). While several studies have confirmed this claim (Ruzek et al., 2016), Cheon et al. focused on benefits teachers received from using autonomous-supportive motivation in their classrooms. Their results suggested teachers receive many benefits. Cheon's et al. results coincided with Deci, La Guardia, Moller, Scheiner, and Ryan (2006), who similarly concluded that individuals who provide the three psychological needs associated with SDT (competence, autonomy, and relatedness) to others, subsequently fulfill their own psychological needs in the process. Cheon et al. demonstrated teachers who use autonomous-supportive strategies in their

classrooms (a) gain motivation to teach, (b) increase their efficacy, and (c) bolster their overall well-being.

Cheon, Reeve, and Song (2016) examined the relationship between student frustration and student motivation. Cheon et al. defined *student frustration* as feeling pressured to think and act in ways prescribed by the teacher that created student annoyance and irritation. To illustrate, student frustration occurred when the teacher took a controlling style, which conveyed an unwillingness to acknowledge or use students' point of view or appreciate their perspectives. Additionally, teacher controlling behaviors may manifest as "yell[ing], communicating through commands, criticiz[ing], and react[ing] negatively to their students' input and perspective" (Cheon et al., 2016, p. 218). This type of behavior included using intimidation tactics and asserting power with direct teacher statements (e.g., Because I said so; I'm the teacher; Do I need to call the principal to this room?). To further illustrate how SDT conceptualizes student frustration, students experience competence frustration when they feel unsuccessful, ineffective, or experience failure when attempting to complete classroom learning activities. Students experience autonomy frustration when they feel forced to complete tasks under pressure at a teacher's request and students experience relatedness frustration when they feel rejected or unaccepted by their teacher and/or peers. These antecedents, leading to student frustration, reflect socioenvironmental factors at least partially controlled by the teacher; therefore, these teacher behaviors can change, thus there can be positive change in the level of motivation in their students.

Cheon et al. (2016) revealed students who had ASIP-educated teachers demonstrated increased satisfaction and engagement while decreasing their frustration and amotivation. This finding confirmed student frustration decreased when teachers used autonomous-supportive

strategies, which led to student motivation. Cheon et al. (2016) suggested this finding explained a critical reason why teachers become more motivated when using autonomous-supportive strategies. As students become less frustrated and more motivated, working conditions improve as teachers see and feel their students becoming more successful.

To conclude, researchers have determined teachers may become more motivated when they learn how to motivate their students using autonomous-supportive classroom strategies (Chatzisarantis & Hagger, 2009; Cheon et al., 2014; Cheon et al., 2018; Cheon, Reeve, & Moon, 2012; Deci et al., 2006; Ruzek et al., 2016). This motivation reduces student frustration and amotivation. Consequently, Cheon and Reeve (2015) define *student amotivation* as "a state of motivational apathy in which students harbor little or no reason to invest the energy and effort that is necessary to learn. . . it is a motivational deficit that is strongly associated with maladaptive functioning" (p. 99). The maladaptive functioning of amotivation leads to poor learning, low academic achievement, and superficial study skills and, in the worst case, eventual dropout. Therefore, investing in learning how to implement autonomous-motivating strategies can produce many positive classroom benefits.

<center>Implications for Professional Development</center>

Guskey (2002) has suggested PD approaches fail because they do not consider teacher motivation or the paradigmatic change process. He argues staff developers should address these two critical factors to properly facilitate effective PD. Hargreaves (2005) has argued educational reform movements have traditionally excluded the emotional dimension of teacher learning, thus reducing its impact. Moreover, the dismissive attitude of policymakers regarding this dimension sends a message that emotion typifies an unimportant consideration. Korthagen (2017) has stated attention and research on the motivational dimension highlights a pressing need, "or in everyday

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language, what teachers *want* and *need* [because] a teachers' ideals are an important driving force in their teaching" (p. 390) These assertions certainly support the need to address the motivational and emotional components of teacher learning; unfortunately, a majority of staff developers and policymakers neglect these important components, which contributes to PD failure. This omnipresent absence of emotion reflects an inconvenient truth for many researchers and administrators who select and implement PD.

After reviewing teacher motivation literature, I argue motivational environmental factors might prompt further research and administrators could use them intentionally when selecting and implementing a specific approach or model of PD. These motivational concerns center on emotion (Sheldon, Ryan, Deci, & Kasser, 2004) and mediate teacher thinking; subsequently, the emotion of supporting students remains the primary source of initiating teacher enactment behaviors. Because teachers act based on perceived student benefits, they might consider PD as meeting the needs of their specific students to become committed at high levels. Additionally, teachers implementing new learning must see the positive outcomes in their students in order to continue to use and enact newly learned strategies. Providing continuous support and feedback can become critical if a teacher does not see improvement based on an incorrect implementation of new learning. Mentors or coaches could make themselves available to correct any fidelity issues leading to negative student outcomes. If teachers perceive new strategies as ineffective, the likelihood of abandoning the strategy increases since the new strategies do not benefit students. Because of their emotional bonds, they could easily return to prior strategies they perceive as effective.

The evidence from ASIP studies strongly suggests teachers who intentionally work to meet the psychological needs of their students can experience self-satisfaction in the three

psychological needs of SDT as well. Satisfying these needs remains paramount because I argue

PD approaches that meet these three psychological needs of teachers will meet their emotional

needs and keep them engaged with ongoing PD activities. Administrators and staff developers

should be aware of how their PD approaches affect teachers in these three areas, so they can

intentionally plan on addressing them and monitor their levels as instruction progresses. I believe

administrators may increase certain psychological needs throughout the duration of the process

as needed by the faculty. Guskey (2002) suggested failing to consider motivational factors may

derail genuine PD intentions, thus prompting his prophetic statement, "The crucial point is that it

is not the professional development *per se,* but the experience of successful implementation that

changes teachers' attitudes and beliefs" (p. 383). While I understand Guskey's point, I argue the

specific PD approach may consider meeting the emotional needs of teachers with deliberate

intention. If the intentional motivational component remains absent, the likelihood of temporary,

superficial compliance may define the result.

To summarize, this literature review disclosed that researchers generally agree effective

PD programs should consider some form of (a) content focus, (b) active learning, (c) coherence,

(d) sustained duration, and (e) collective participation. Similarly, PD programs focusing on

mathematics may include these elements with an additional focus on (a) content, (b) pedagogy,

and (c) PCK. Additionally, the concept of LSOA offers a specific form of PD designed to help

mathematics teachers change their instructional paradigm to include teaching from an inquiry-

based approach. Although LSOA does not consider a specific model of teacher motivation, I

argue the incorporation of SDT can provide an appropriate model. This includes purposefully

manipulating social and environmental factors to increase the three psychological needs of

teachers—competence, autonomy, and relatedness. According to Guskey (2002), many PD

efforts fail due to a lack of teacher motivation; therefore, careful consideration of this often-missing element justifies further consideration and research.

    The next chapter describes how a single case study research design can best answer the research questions of the current study, in addition to describing the study's (a) sample selection, (b) data sources, (c) data analysis, (d) triangulation, and (e) trustworthiness. The chapter ends with a discussion of limitations of the current research study.

CHAPTER 3

METHODOLOGY

As school accountability increases for mathematics achievement, public school administrators are charged not only with increasing teacher effectiveness through quality professional development (PD), but they might also attend to the motivational needs of the teachers in their schools. Although the search for the most effective forms of PD is not new, attending to the emotional needs of teachers through intentional motivational techniques illustrates an often-ignored component (Chatzisarantis & Hagger, 2009; Gorozidis & Papaioannou, 2014; Hargreaves, 2005; Korthagen, 2017). As a result, this study investigated how lesson study with open approach (LSOA) shaped contextual factors that impacted teachers' autonomous motivation and described the effectiveness of those factors as perceived by teachers. Based on inductive thematic analysis, the results of this study offered a description of teachers' experiences, which may inform a principal's instructional leadership decisions. The study presents impactful information because many principals do not receive adequate instructional leadership training from their university coursework (Honig, 2012; Lemoine, McCormack, & Richardson, 2014

Using self-determination theory (SDT) as a theoretical framework, this dissertation study supported an interpretivist paradigm by using a single case study methodology to explain how teachers experienced the phenomenon of motivation within the context of LSOA. The research questions (RQs), along with subquestions (SQs) for RQ1 guiding this study are:

- RQ1. How do teachers perceive the motivational contextual factors offered by lesson study with open approach?
  - SQ1. How do teachers experience competence when participating in LSOA?
  - SQ2. How do teachers experience relatedness when participating in LSOA?

○ SQ3. How do teachers experience autonomy when participating in LSOA?

- RQ2. In what ways does lesson study with open approach connect with teacher motivation?

This chapter includes specific procedures and designs used to address the research questions in addition to describing the rationale. The chapter also contains a description of the (a) research design, (b) researcher's role, (c) sample selection, (d) data collection, and (e) data analysis. The triangulation process is discussed, followed by a review of strategies used to promote trustworthiness. The chapter ends with a discussion of study limitations.

Research Design

Case study methodology underpinned this research due to its ability to answer the research questions and support appropriate ontological and epistemological considerations. To support this assertion, Flyvbjerg (2006) reminds us, case study is a "particular research methodology" (p. 219) and advances the idea that case studies produce exemplars, which lay the foundation for a discipline. Baxter and Jack (2008) describe case study as an approach to research and specifically use the term "qualitative case study methodology" (p. 544). Bryman (2012) refers to case study as a research design that is "a framework for the generation of evidence that is suited both to a certain set of criteria and to the research question in which the investigator is interested" (p. 45). Although Bryman (2012) does not specifically use the word methodology, his definition matches Crotty's (2015) articulation of methodology, which considers "the strategy, plan of action, process, or design lying behind the choice of particular methods . . ." (p. 3). In sum, these authors consider case study to be a methodology capable of providing a robust framework for supporting qualitative research.

Yin (2018) addressed case study ontological and epistemological concerns by suggesting the researcher should apply the appropriate theoretical perspective. Yin suggested case study was

flexible and supported a variety of qualitative or quantitative approaches. He saw this flexibility

as a strength and argued case study was viable both as a data collection tactic and as a design

framework. Yin (2018) defined case study as an empirical method that "investigates a

contemporary phenomenon (the case) in depth and within its real-world context, especially when

the boundaries between phenomenon and context may not be clearly evident" (p. 15). This

definition allows researchers to explore simple and complex phenomenon within specific

context. Moreover, case study is context-dependent; it relies on understanding how individuals

react and experience their reality based on their contextual real-world environment. According to

Yin, case study guides the structure and design of how research examines context-specific

phenomenon, but it is up to the researcher to correctly apply methods that incorporate

complementary theoretical perspectives.

To further support using case study as a methodology, Yin (2018) asserted that research

questions associated with case study methodology answer *how* and *why* individuals experience

various phenomena. This leads to the description, explanation, or exploration of how individuals

perceive the essence of their lived experiences within specific context. Yin suggested case study

research was appropriate under the following conditions: (a) the researcher asks how and why

questions, (b) the researcher does not manipulate the participant's behaviors, (c) the researcher

believes the contextual or environmental conditions influence the individual's experience of the

phenomenon, and (d) the distinctions between the phenomenon and the context are unclear or

underresearched.

My dissertation study aligns with Yin's (2018) case study criteria on all levels. One

question begins with *how* and this researcher did not influence participants. Additionally, the

literature review showed that environmental conditions can influence teacher motivational

behavior, thus supporting Yin's third criteria of context influencing phenomenon. Lastly, the literature review indicated a dearth of research examining the phenomenon of motivation; therefore, the topic of motivation in relation to LSOA is underresearched, particularly regarding LSOA implementation in the United States (U.S.), thus meeting Yin's fourth criteria.

<center>Researcher's Role</center>

According to Bryman (2012), qualitative methods initiate an inquiry process in which the researcher becomes the data collection instrument. Bryman's claim advances the notion that researchers' ideas, values, beliefs, and experiences shape epistemological views influencing the development and creation of knowledge. Additionally, epistemological beliefs guide the researcher's judgement of what information to include or exclude in the results (Finlay, 2002). Taken together, these decisions can certainly introduce bias (Hesse-Biber, 2017). To address this potential bias, I self-reflected throughout the data collection process. Self-reflection included analyzing my relationship with the participants to make sure I did not develop a fondness, sympathy, or dislike of the participants that influenced any data decisions or interpretations. My decisions about data inclusion/exclusion were based on the data's ability to answer the research questions with fidelity. Additionally, I considered my positionality, as well as my status throughout the reflexivity process.

Finlay (2002) described the concept of reflexivity and its ability to take a variety of forms. For example, reflexivity can include: (a) an open and detailed description of methodology, (b) examining biased and unconscious reactions to participant's experiences, (c) describing the relationship between the researchers and researched, and (d) describing how the research was co-created. The last two forms of reflexivity relate to positionality, which considers where the researcher stands in relation to the participants. This includes issues of

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access, power, and the researcher's status as being an insider or outsider in relation to the study participants (Merriam et al., 2001). Furthermore, the concept of insider/outsider relates to the degree of connectedness the researcher has with the participants. For example, researchers may reasonably assume that similarities of culture, race, religion, gender, and class can better facilitate a researcher's access to similar participants, thus expediting shared meanings and the soundness of findings (Merriam et al., 2001).

Before I could situate myself in relation to research participants, I had to first understand myself as a researcher. I asked myself what informs my identity and how that identity could influence my research. To illustrate, I am a white Christian male who is 49 years old. I grew up in a supportive environment and consider myself middle class. I have a bachelor's degree in history from Texas A&M University and a master's degree in educational administration from Texas State University. I am currently earning a doctorate in curriculum and instruction from the University of North Texas. I have acquired 19 years of experience working in the Texas public school system ranging from middle school teacher to middle school principal. Finally, I am married with no children.

The culmination of these aforementioned experiences formed my epistemological beliefs and ontological orientations. For example, I believe knowledge is subjective and constructed through the shared language of specific communities (Grbich, 2013). Moreover, people create their realities through social interactions of lived experiences and each person individually constructs their realities. As a result, I believe there are multiple realities of how people make sense of their environments. Therefore, I position myself as a qualitative researcher who supports the constructionist/interpretivist paradigm.

After working with teachers for 13 years, I witnessed the amount of support teachers

needed to become confident and efficacious. Not only did teachers need support, they needed differing kinds of support to meet their individual needs. Based on my experiences, I noticed a general approach to PD worked for some teachers; however, other teachers needed a precise and focused approach to meet their needs. Seeing teachers become frustrated to the point of leaving the profession helped me realize the importance of meeting their individual needs and providing contextual factors to increase their motivation. While I recognized the importance of providing this support, I did not have the knowledge or understanding to meet the needs of every teacher. For that reason, I dedicated this research to exploring how teachers experience PD. I wanted to understand more about these experiences, so other principals and staff developers might understand the contextual factors that lead to positive PD experiences for teachers.

To align my research goals with my preferred paradigm, I anticipated several considerations. I believe subjectivity has value; therefore, I construct knowledge as a combined effort between myself, as researcher, and the participants, because they are the experts. It is their constructed realities I wished to describe and explore. To gain authentic accounts, I preferred to acquire access as an indigenous insider, which reduced perceived power imbalances between researcher and participant (Chavez, 2008). From this perspective, I hoped to make connections with teachers who endorsed similar values and beliefs about the importance of PD. I believe both the teacher and I served as authorities who could speak on the topic of PD.

While my passion for PD is strong, I remained focused on the space between the participant and the phenomenon without interjecting my own biases. I wanted to learn about PD approaches that increase student achievement and teacher motivation, so I was diligent when making accurate interpretations. I did not want to overemphasize a contextual feature that I believed would work. I stayed focused on the experience of the teacher. This focus helped to

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increase the integrity of my results. By being reflexive and open about my positionality, my readers can make their own judgements.

Population

The participants for this study were selected from a pool of 17 secondary mathematics teachers (i.e., population) who participated in a university-sponsored PD entitled algebra PD (Title of professional development offering is a pseudonym). To provide context for this study, it was imperative to understand the purpose and scope of the algebra PD; therefore, this section describes the (a) population, (b) timeline, and (c) curriculum of the PD program.

The 17 teachers who participated in the algebra PD were secondary mathematics teachers employed in public schools located in the south-central portion of the U.S. The algebra PD program advertised for teachers and provided application forms to interested individuals. Therefore, all 17 teachers volunteered and researchers accepted them though a formal application process. As part of the grant supporting the PD, all volunteer teachers received the following benefits: (a) paid travel expenses to a state mathematics conference, (b) software, (c) books, (d) various manipulatives, (e) a stipend, and (f) the option to gain credit for two graduate courses. All participating teachers taught either Algebra I, pre-algebra or $7^{th}/8^{th}$ grade mathematics, and teacher experience ranged from one to 26 years.

Participant demographics included 13 females and four males ($n = 17$) who represented the following diverse backgrounds: eight African Americans, seven Caucasians, one other, and one Hispanic. The population taught in urban public schools with 14 teaching middle school, two teaching high school, and one teaching junior high. Thirteen of the teachers taught on different campuses, while two pairs taught on two different campuses. In other words, Teachers A and B taught on the same campus, Teachers C and D taught on the same campus, while the remaining

teachers taught at 13 different campuses; consequently, the 17 teachers taught on 15 different

campuses (see Table 1). All teacher campuses, in addition to the supporting university, were

located within reasonable driving distances of one another.

All teachers' schools met accountability standards, as determined by the governing state,

with five campuses ($\overline{x} = 33\%$) receiving state distinctions (i.e., recognition of high achievement

in comparison to 40 similar campuses based on type, size, and student demographics).

Additionally, Mooney M.S., Franklin H.S., and Guthrie M.S. did not meet the Index I threshold

of 60%; however, schools meet state expectations if they meet either Index I or Index II. Due to

this caveat, schools failing Index I ultimately met state accountability because they met Index II,

Index III, and Index IV requirements. When examining the overall campus passing rate for all

mathematics assessments for all grade levels, the scores ranged from 57% (low) to 92% (high).

Additionally, a majority of participating schools ($\overline{x} = 80\%$) were classified as Title I due to the

percentage of economically disadvantaged students being greater than 40% (United States

Department of Education, 2015).

The algebra PD was a university-sponsored mathematics PD program specifically

designed to enhance mathematics content and pedagogical knowledge. The two-year program

began in April 2016 and ended February 2018. The university-based researchers selected the

curriculum and instructed the teachers, along with a doctoral student. The curriculum included

(a) formative assessment, (b) an inquiry-based instructional model, (c) classroom discussion

strategies, and (d) the LSOA process. The researchers taught the 5E lesson model (Bybee et al.,

2006) and how to question for conceptual understanding (Driscoll, 1999; Smith & Stein, 2011).

This curriculum facilitated pedagogical understanding critical to leading classroom discussions

designed to promote mathematics conceptual understanding.

Table 1

Demographic Information of Participating Schools

School Pseudonym	Campus Grade Levels	Campus Student Population	Campus Demographics	Accountability	% Passing Mathematics Assessment for 2017	Title 1 Status
Mooney MS	6-8	960	African American 17% Hispanic 61% Caucasian 3% Asian 19% Two or More Races 0%	Met Standard Index 1: Fail Index 2: Pass Index 3: Pass Index 4: Pass	57%	Title 1 = Yes Economically Disadvantaged 96%
Bateman MS	7-8	800	African American 40% Hispanic 35% Caucasian 24% Asian 1% Two or More Races 0%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	61%	Title 1 = Yes Economically Disadvantaged 77%
Mann MS	6-8	1,380	African American 23% Hispanic 19% Caucasian 53% Asian 3% Two or More Races 2%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	84%	Title 1 = No Economically Disadvantaged 31%
Stanley JH	6-8	760	African American 16% Hispanic 17% Caucasian 43% Asian 20% Two or More Races 4%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	87%	Title 1= No Economically Disadvantaged 26%
Glickman MS	7-8	1,100	African American 77% Hispanic 20% Caucasian 2% Asian 0% Two or More Races 1%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	79%	Title 1 = Yes Economically Disadvantaged 85%

School Pseudonym	Campus Grade Levels	Campus Student Population	Campus Demographics	Accountability	% Passing Mathematics Assessment for 2017	Title 1 Status
Jardine MS	6-8	1,000	African American 15% Hispanic 78% Caucasian 6% Asian .5% Two or More Races .5%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	72%	Title 1 = Yes Economically Disadvantaged 84%
Franklin HS	9-12	1,340	African American 38% Hispanic 51% Caucasian 2% Asian 8% Two or More Races 1%	Met Standard Index 1: Fail Index 2: Pass Index 3: Pass Index 4: Pass	67%	Title 1 = Yes Economically Disadvantaged 95%
Sullivan MS	6-8	1,100	African American 19% Hispanic 78% Caucasian 2% Asian 0% Two or More Races 1%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	75%	Title 1 = Yes Economically Disadvantaged 95%
Wexler HS	9-12	1,000	African American 3% Hispanic 24% Caucasian 68% Asian 2% Two or More Races 3%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	86%	Title 1 = Yes Economically Disadvantaged 43%
Joyce MS	6-8	1,170	African American 7% Hispanic 84% Caucasian 7% Asian 1% Two or More Races 1%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	72%	Title 1 = Yes Economically Disadvantaged 87%
Phoenix MS	7-8	860	African American 15% Hispanic 18% Caucasian 49% Asian 11%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass	92%	Title 1 = No Economically Disadvantaged 23%

School Pseudonym	Campus Grade Levels	Campus Student Population	Campus Demographics	Accountability	% Passing Mathematics Assessment for 2017	Title 1 Status
			Two or More Races 7%	Index 4: Pass		
McLaren MS	6-8	1,300	African American 3% Hispanic 94% Caucasian 2.5% Asian .5% Two or More Races 0%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	65%	Title 1 - Yes Economically Disadvantaged 88%
Jacoby MS	6-8	1,300	African American 17% Hispanic 80% Caucasian 2% Asian .5% Two or More Races .5%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	75%	Title 1 = Yes Economically Disadvantaged 75%
Guthrie MS	6-8	800	African American 53% Hispanic 44% Caucasian 2% Asian .5% Two or More Races .5%	Met Standard Index 1: Fail Index 2: Pass Index 3: Pass Index 4: Pass	57%	Title 1 = Yes Economically Disadvantaged 83%
Newman JH	6-8	880	African American 27% Hispanic 44% Caucasian 18% Asian 8% Two or More Races 3%	Met Standard Index 1: Pass Index 2: Pass Index 3: Pass Index 4: Pass	86%	Title 1 = Yes Economically Disadvantaged 48%

Note. Read the table horizontally by row. Index 1 = total passing percentage of all campus subject-area tests; Index 2 = student growth measure for all students taking reading and mathematics tests; Index 3 = closing performance gaps for two lowest performing groups (from previous year) and economically disadvantaged students; Index 4 = meets grade level score on subject-area tests (at least two) for eight student groups. Texas Education Agency, 2018, *2017 Accountability Rating System*. Reports reflect the 2016-2017 school year. Retrieved from https://tea.texas.gov/2017accountability.aspx

Additionally, the researchers taught short-cycle formative assessment strategies to facilitate collecting information related to student mathematical thinking. Taken together, this instruction supported the teachers as they learned how to enact LSOA. The LSOA support included teaching how to use observation and debriefing protocols to facilitate the process. Lastly, researchers developed the *AssessToday* observation protocol to evaluate and measure the implementation of the specific curriculum objectives (Eddy, Harrell, & Heitz, 2017).

During the second year of algebra PD, the teachers received a total of 30 instructional hours during the summer and 20 instructional hours during the school year. The researchers intentionally assigned teachers into teams of four or five (e.g., four teams contained four members and one team contained five members) using the Team-Creation Framework (Petty, Eddy, & Pratt, 2018). The researchers began the team-formation process by evaluating both mathematics content knowledge and teaching efficacy. Teachers completed the Teacher Content Knowledge Survey (Tchoshanov, 2011) or the Diagnostic Teacher Assessment for Mathematics and Science (Saderholm, Ronau, Brown, & Collins, 2010) to reveal the level of mathematics content knowledge determined by the subject they taught. The teachers also took the Algebra Teacher's Self-Efficacy Instrument (Wilkerson et al., 2018) to assess teacher efficacy.

After collecting initial content knowledge and efficacy information, the researchers intentionally teamed the population by dividing them into quartiles based on the Jenks Natural Breaks Optimization Process (Jenks, 1967), which ranked teachers as Class 1 (low), Class 2 (medium-low), Class 3 (medium-high), or Class 4 (high). The researchers created teams by balancing members according to their class, which resulted in three teams of four and one team of five. After the initial team formations, the teachers completed a team-selection form and listed individuals with whom they preferred to work. They also indicated teachers whom they believed

would inhibit their professional growth (i.e., non-preferred) in a collaborative setting. After examining the last factor of preference, researchers rearranged the teams honoring the teachers' request to the highest degree possible, while maintaining balance according to the Jenks' quartiles. The final teaming matched each teacher with one or two of their preferred choices and did not include anyone reported as non-preferred (see Table 2).

All teachers' schools met accountability standards, as determined by the governing state, with five campuses ($\overline{x}$ = 33%) receiving state distinctions (i.e., recognition of high achievement in comparison to 40 similar campuses based on type, size, and student demographics). Additionally, Mooney M.S., Franklin H.S., and Guthrie M.S. did not meet the Index I threshold of 60%; however, schools meet state expectations if they meet either Index I or Index II. Due to this caveat, schools failing Index I ultimately met state accountability because they met Index II, Index III, and Index IV requirements. When examining the overall campus passing rate for all mathematics assessments for all grade levels, the scores ranged from 57% (low) to 92% (high). Additionally, a majority of participating schools ($\overline{x}$ = 80%) were classified as Title I due to the percentage of economically disadvantaged students being greater than 40% (United States Department of Education, 2015).

The algebra PD was a university-sponsored mathematics PD program specifically designed to enhance mathematics content and pedagogical knowledge. The two-year program began in April 2016 and ended February 2018. The university-based researchers selected the curriculum and instructed the teachers along with a doctoral student. The curriculum included formative assessment, an inquiry-based instructional model, classroom discussion strategies, and the LSOA process. The researchers taught the 5E lesson model (Bybee et al., 2006) and how to question for conceptual understanding (Driscoll, 1999; Smith & Stein, 2011). This curriculum

facilitated pedagogical understanding critical to leading classroom discussions designed to promote mathematics conceptual understanding. Additionally, the researchers taught short-cycle formative assessment strategies to facilitate collecting information related to student mathematical thinking. Taken together, this instruction supported the teachers as they learned how to enact LSOA. The LSOA support included teaching how to use observation and debriefing protocols to facilitate the process. Lastly, researchers developed the *AssessToday* observation protocol to evaluate and measure the implementation of the specific curriculum objectives (Eddy, Harrell, & Heitz, 2017).

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of five. After the initial team formations, the teachers completed a team-selection form and listed individuals with whom they preferred to work. They also indicated teachers whom they believed would inhibit their professional growth (i.e., non-preferred) in a collaborative setting. After examining the last factor of preference, researchers rearranged the teams honoring the teachers' request to the highest degree possible while maintaining balance according to the Jenks' quartiles. The final teaming matched each teacher with one or two of their preferred choices and did not include anyone reported as non-preferred (see Table 2).

Lastly, 16 teachers volunteered to participate during the first year; however, due to attrition, three teachers left the program at the end of Year 1. As a result, the researchers added four new teachers during the second year for a total of 17. The additional four teachers received the same benefits as the first-year teachers. All teachers signed an informed consent form, which communicated the expectations of the study along with withdrawal options. Study organizers ensured anonymity, confidentiality, and no harm. Additionally, Institutional Review Board approval sanctioned the study for two years.

<div align="center">Data Sources</div>

Semi-Structured Interviews

The following three sources supported data collection: (a) semi-structured interviews, (b) written reflections, and (c) the Teamwork Quality survey (TWQ; Hoegl & Gemuenden, 2001). The semi-structured interviews functioned as the primary information source, while written reflections and the TWQ survey served to triangulate the information by providing multiple sources to answer the research questions (Yin, 2018).

Table 2

Algebra Professional Development Team Assignments

		Content Knowledge			Knowledge Efficacy in Algebra			Personal Teaching Efficacy in Algebra			Total Team Mean	Number of Preference Matches	Number of Preference Conflicts
		Jenks Class	Score Mean	Team Mean	Jenks Class	Score Mean	Team Mean	Jenks Class	Score Mean	Team Mean			
Team 1/School													
Aria	(Franklin)	4	85%		4	88%		2	56%			No Pref.	0
Paula	(Bateman)	1	8%	52%	2	65%	73%	3	65%	66%	63.6	2	0
Lisa[a]	(Guthrie)	3	65%		2	70%		3	69%			2	0
Randall[a]	(Stanley)	2	50%		2	70%		3	70%			2	0
Team 2/School													
Marie	(Sullivan)	2	55%		3	77%		2	48%			1	0
Sharon	(Jardine)	2	50%	62%	1	31%	72%	1	37%	57%	63.6	1	0
Blake	(Phoenix)	4	85%		4	96%		4	78%			2	0
Chloe	(Mann)	3	58%		3	82%		3	63%			1	0
Team 3/School													
Elena	(Glickman)	4	80%		3	74%		2	57%			1	0
Juanita	(Glickman)	2	40%	55%	2	59%	74%	3	63%	65%	64.6	1	0
Henry	(Newman)	3	60%		4	85%		4	84%			No Pref.	0
Natasha[a]	(McLaren)	2	40%		3	78%		2	54%			1	0
Team 4 /School													
Kamace	(Mann)	3	68%	47%	2	70%	68%	3	68%	63%	59.3	2	0
Ofelia[a]	(Jacoby)	1	20%		1	23%		1	21%			2	0

		Content Knowledge			Knowledge Efficacy in Algebra			Personal Teaching Efficacy in Algebra			Total Team Mean	Number of Preference Matches	Number of Preference Conflicts
		Jenks Class	Score Mean	Team Mean	Jenks Class	Score Mean	Team Mean	Jenks Class	Score Mean	Team Mean			
Fatima	(Mooney)	2	35%		4	95%		4	92%			1	0
Deanne	(Wexler)	3	60%		3	75%		3	65%			2	0
Gino	(Joyce)	2	50%		3	77%		3	70%			1	0

Note. Pseudonyms used in table. Source: Petty et al., 2018).

Written Reflections

The use of reflections written by the teacher participants served as additional data with the purpose of providing more than one source of evidence. Prior to this dissertation study, researchers asked the teachers to provide written responses to 20 reflective prompts during the second year of the algebra PD (see Appendix A). Four written reflections from the 20 served to increase the number of data sources enhancing the "sample of words to the voice" (Onwuegbuzie & Leech, 2007, p. 108; see Table 3).

Table 3

Research Questions by Data Source and Analysis Technique

Research Question	Available Data Source	Analysis Approach
RQ1: How do teachers perceive the motivational contextual factors offered by lesson study with open approach?		
SQ1: How do teachers experience competence when participating in LSOA?	Semi-Structured Interviews, Q 5-7 (see Table 17)	Thematic Analysis (Braun & Clark, 2006)
SQ2: How do teachers experience relatedness when participating in LSOA?	• Semi-Structured Interviews, Q 8-9 (see Table 17) • Written Reflections (6-7; see Appendix A) • Teamwork Quality Survey Data Analysis Findings	• Thematic Analysis (Braun & Clark, 2006) • Content Analysis (Graneheim & Lundman, 2004) • Paired Sample t-Tests (Pallant, 2016)
SQ3: How do teachers experience autonomy when participating in LSOA?	Semi-Structured Interviews, Q 10-12 (see Table 17)	Thematic Analysis (Braun & Clark, 2006)
RQ2: In what ways does lesson study with open approach connect with teacher motivation?		
	• Semi-Structured Interviews Q 13-17 (See Appendix A) • Written Reflections (2-3; see Appendix A)	• Thematic Analysis (Braun & Clark, 2006) • Content Analysis (Graneheim & Lundman, 2004)

Note. RQx = Research Question (followed by number); Q x-y = Questions (followed by numbers).

Teamwork Quality Survey

The TWQ survey (Hoegl & Gemuenden, 2001) served to develop a comprehensive understanding of collaboration in the context of teams and to measure collaborative interaction quality with validity and reliability. The construct of team collaboration includes the following six facets: (a) communication, (b) coordination, (c) balance of member contributions, (d) mutual support, (e) effort, and (f) cohesion (Hoegl & Gemuenden, 2001). The following section describes each facet in detail.

Communication

Communication is critical among collaborating individuals and essentially describes the process of information exchange. Hoegl and Gemuenden (2001) characterize communication with the following four descriptors: (a) frequency, (b) formalization, (c) structure, and (d) openness. *Frequency* refers to the number of occurrences in which information exchanges from one individual to another. *Formalization* refers to communicating within agreed-upon conventions, such as scheduled meetings, presentations, and board reports; however, formalization also includes spontaneous communication such as hallway conversations and text messages. *Structure* refers to how individuals go about exchanging information, such as a regimented chain-of-command process versus a free exchange of information among equal individuals. Lastly, *openness* refers to feeling encouraged to bring forth information, as opposed to refraining due to various reasons.

Coordination

The quality of collaboration depends on the coordination of each member's activities. To illustrate, quality increases when member activities coordinate in a manner promoting efficiency and time management (Hoegl & Gemuenden, 2001). Team members must agree to achieve

common goals and then act in an orchestrated manner, so members can realistically achieve their goals. Coordination decreases if team members work on different goals or unknowingly work on the same task.

Balance of Member Contributions

Each team member should have the ability to provide input when working in collaboration. The balance of input decreases if one member dominates the conversation over others. Additionally, individuals who hesitate or do not contribute their knowledge, ideas, or experiences diminish the overall quality of the input. Hoegl and Gemuenden (2001) state, "it is considered essential to TWQ that contributions to the team task are balanced with respect to each member's specific knowledge and experience" (p. 437). The addition of multiple perspectives is a major contributor to developing innovative ideas and solving problems.

Mutual Support

Hoegl and Gemuenden (2001) contend collaboration quality increases with member cooperation versus member competition. They argue competition can create contentious relationships (i.e., suspicion, cynicism, aggravation), which hurt overall interpersonal interactions, thus leading to poor-quality collaboration. Competition includes (a) competition for resources, (b) leadership, (c) prestige, and (d) looking effective in the eyes of a supervisor. Conversely, cooperation is far more productive and includes (a) respectful interactions, (b) helping each other, and (c) valuing the input of all members. Mutual support is the process of creating a cooperative environment.

Effort

Effort reflects the amount of exertion each team member makes to achieve the common

goal. Hoegl and Gemuenden (2001) suggest quality collaboration increases when all group members understand the amount of effort needed to accomplish their goal and all members exert similar amounts of effort. Effort norms include (a) sharing the workload, (b) prioritizing group needs over individual needs, and (c) asking for help to avoid falling behind.

Cohesion

Cohesion refers to the level of desire each member has to stay committed to the group. Cohesion includes features promoting respect, interest, and diplomacy. Hoegl and Gemuenden (2001) consider cohesion features to include (a) positive interpersonal interactions (i.e., respect, trust, welcoming attitudes), (b) valuing the team goals, and (c) having a positive team identity engendering group pride. They argue, "If team members lack a sense of togetherness and belonging, there is little desire to keep the team going, then intensive collaboration seems unlikely" (Hoegl & Gemuenden, 2001, p. 438). Accordingly, an acceptable level of cohesion is necessary for effective collaborative interactions.

In sum, Hoegl and Gemuenden (2001) espouse the single factor of team collaboration encompasses six facets relating to the "quality of interactions within teams," (p. 436) as opposed to focusing on facets centering on task completion (i.e., They do not measure what the team produces; they measure the quality of interactions). Moreover, they claim satisfaction from working in collaborative groups increases motivation to continue working in future collaborative contexts, because working in teams increases the opportunity to learn new skills, thus satisfying desires for professional growth. They argue higher levels of teamwork quality positively correlate to higher levels of effectiveness and efficiency, as well as satisfaction and learning. Therefore, they recommend leaders might deliberately improve the six facets of collaborative teams to increase worker satisfaction and production.

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Teamwork Quality Survey Psychometrics

Principal component analysis from both team and individual factor analysis confirmed the latent construct of team collaboration loaded cleanly onto one factor based on the six facets. Construct validity indicated one distinct factor, Team Collaboration, explained 71.5% of the variance. All six TWQ facets loaded between 0.71 and 0.89, with ideal loading being > 0.40 (Valentine, Nembhard, & Edmondson, 2013). The total eigenvalue of 4.29 far exceeded the acceptable level of > 1.0. The reliability based on Cronbach's alpha coefficient equaled 0.9, which fell into the acceptable range of .7 to .9 (Valentine et al., 2013). Interrater agreement and reliability ranged from 0.79 to 0.95, thus meeting acceptable scores, which are > 0.7 (Valentine, et al., 2013). Hoegl and Gemuenden (2001) achieved content validity for the TWO survey by conducting a comprehensive literature review to develop items, followed by a pilot test that resulted in revisions.

Hoegl and Gemuenden (2001) included survey questions with reverse score instructions in their psychometric article; however, they did not include any other survey information. The following questions required reverse coding: four, six, seven, 14, 17, 27, 29, and 33. I contacted Dr. Hoegl and received permission to use the survey for the study, but he referred to his psychometric article when responding to Likert scale and scoring questions. As a result, the survey was modified by including a 6-point Likert scale ranging from 1 (*not very well*) to 6 (*extremely well*). In addition, I removed one question that read, "There was personal attraction between the members of our team" (Hoegl & Gemuenden, 2001, p. 447). This question was removed due to concerns that teachers would interpret attraction from a romantic perspective. This potential for misinterpretation had the capability to skew the overall survey results. As a result, this question was removed from the cohesion facet, which consisted of 10 questions that

obtained the highest factor loading of 0.89. Although this question measured cohesion, the potential for misinterpretation remained high. The removal of the question reduced the total number of cohesion questions from 10 to nine, thus reducing the total number of survey items from 37 to 36 (see Table 4).

Table 4

Number of Questions Used to Measure Each Facet

Facet	Number of Survey Questions
1. Communication	10
2. Coordination	4
3. Balance of Member Contributions	3
4. Mutual Support	6
5. Effort	4
6. Cohesion	9[a]
Total	36

Note. [a]Original survey included 10 questions. Adapted from Hoegl & Gemuenden, 2001.

Sample Selection

When evaluating the most appropriate manner to select the sample, two considerations guided the decision-making process related to data saturation. These considerations included capturing the participants' full story and recruiting the appropriate number of individuals to reach theoretical saturation (Fusch & Ness, 2015; Onwuegbuzie & Leech, 2007). To capture the participant's full story, Onwuegbuzie and Leech (2007) suggested the researcher present a rationale to defend the "sample of words to the voice" (p. 108), representing the concept of obtaining the appropriate amount of information to accurately understand and portray an individual's lived experience of a phenomenon. To do so includes collecting enough varied information to ensure the researcher can extract the proper meaning from each individual. In

other words, the researcher should attempt to properly capture the participant's story using the most appropriate data collection technique.

Sample of Words to the Voice

To capture this "sample of words to the voice" (Onwuegbuzie & Leech, 2007, p. 108), I drew data from three sources: (a) semi-structured interviews, (b) written reflections, and (c) the TWQ survey (Hoegl & Gemuenden, 2001). The primary information source was semi-structured interviews. This data collection method was selected due to its capacity to capture rich and detailed information focused on an individual's lived experiences related to a specific phenomenon. According to Hesse-Biber (2017), in-depth interviews promote explanatory studies and support researchers who "are looking for patterns that emerge from the thick descriptions of social life recounted by their participants" (p. 106). Additionally, Merriam (1998) and Yin (2018) encouraged the use of interviews when conducting case studies. Therefore, using semi-structured interviews, along with the written reflections and the TWQ survey (Hoegl & Gemuenden, 2001), satisfied the expectation of meeting the "sample of words to the voice" (Onwuegbuzie & Leech, 2007, p. 108) for this study.

Theoretical Data Saturation

The second major consideration of sampling was choosing the appropriate number of participants to reach data saturation (Onwuegbuzie & Leech, 2007). By enlisting the proper number of participants and using multiple forms of data, the likelihood of adding credibility to the study increased (Hesse-Biber, 2017). Although research examining standard sample sizes for qualitative researchers was thin (Fugard & Potts, 2015; Malterud, Siersma, & Guassora, 2015), several qualitative authors have offered suggestions. Creswell (2002) has suggested case study research can achieve saturation after examining three to five individuals. Morse (1994)

recommended including at least six individuals when the researcher was seeking to understand

perceptions of phenomena, and Kuzel (1992) has suggested six to eight participants can satisfy

saturation requirements. In reference to thematic analysis, Braun and Clarke (2013)

recommended small interview-based studies should include between six and 10 participants.

Therefore, the sample size for this study included eight teachers who participated in the algebra

PD program. Though 17 teachers completed the PD, analyzing data collected from eight

teachers, using hour-long, semi-structured interviews, yielded a proper amount of data to support

saturation.

Although various authors have offered sample size recommendations (Braun & Clarke,

2013; Creswell, 2002; Kuzel, 1992; Morse, 1994), they have done so without describing how

they reached their conclusions (Onwuegbuzie & Leech, 2007). While Emmel (2013) criticized

this fact, Malterud, et al. (2015) remind us, "Sample size cannot be predicted by formulae or by

perceived redundancy" (p. 2), due to the subjective nature inherent in qualitative research

designs. As a result, Malterud et al. developed a model using the concept of *information power*

to guide sample size decisions for interview-based qualitative research. To illustrate, the authors

argued fewer participants were necessary when: (a) the study's aim was narrow, (b) the

participants were knowledgeable about the phenomenon, (c) the study was based on current

theory, (d) the researchers obtained quality interview data, and (e) the study was based on a

single case. Their argument to enlist fewer participants dovetailed with the parameters of this

study because the topics of SDT and LSOA were both specific; the participants already

experienced the LSOA process, so they were knowledgeable about the topic; and the premise of

the study was based on current theory

The study did not require a higher number of participants; therefore, based on the sample

size recommendations of Creswell (2002), Kuzel (1992), Morse (1994), and Braun and Clarke (2013), I achieved data saturation. The combined mean of these recommendations equaled six individuals, so including eight teachers met or exceeded the mean suggestions (see Table 5). Additionally, when applying this study to the information power model (Malterud et al., 2015), there was no need to consider a larger sample size.

Table 5

Calculating Sample Size Means for Case and Interview-Based Studies

Author (Year of Publication)	Recommended Sample Size	Sample Size Mean
Creswell (2002)	3 to 5	4
Morse (1994)	6	6
Kuzel (1992)	6 to 8	7
Braun & Clarke (2013)	6 to 10	8
Total Mean		6.25

Sampling

The method for selecting the sample of participants included nonrandom sampling, due to the qualitative nature of the study. When choosing who and how to select research participants, the study objective guided the decision. If a study objective centers on providing generalizable results, the researcher should randomly select a large number of participants (Bryman, 2012). Conversely, if the objective of the study centers on describing a phenomenon, as experienced by specific individuals, the researcher should purposefully select participants who can offer rich and descriptive accounts of the phenomenon under study (Bryman, 2012). To obtain the number of participants to satisfy these criteria, a purposive sampling technique of maximal variation was used to select the eight teachers (Plano Clark & Creswell, 2010).

Maximal variation sampling emphasizes collecting a range of participant experiences to

comprehensively describe how a group of individuals experienced a phenomenon. In this case study, the phenomenon is motivation. Ryan and Deci (2017) stated, "SDT is practical insofar as it points to how features of context more or less facilitate or undermine the motivations and satisfactions underlying effective self-regulation and wellness" (p. 4) which suggests that social and environmental factors can either increase or decrease an individual's motivation. Therefore, selecting participants who experienced both positive and negative occurrences are more likely to report contextual factors leading to increases or decreases in motivation.

Participants

When implementing the maximal variation purposive sampling method (Plano Clark & Creswell, 2010), I used the difference between pre- and post- means of the TWQ survey to create quartiles from least to greatest. This produced a list of participants who reported a variety of interaction quality reflecting their collaborative experiences, ranging from negative (i.e., Randall -1.1) to positive (i.e., Henry +3.47). Although a total of 17 teachers participated in the algebra PD, three did not complete the pre- or post-survey. To illustrate, two subjects did not complete the pre-survey but completed the post-survey, while a third subject completed the pre-survey but did not complete the post-survey. This reduced the pool of available subjects to 14 (see Table 6). After developing quartiles, I placed participants in random order within each quartile; italicized names indicate study participants (see Table 7).

Table 6

Participant Difference between Pre- and Post-Teamwork Quality Survey by Quartile & Time in Program

Participant/Quartile	Difference	Time in Algebra PD
Quartile 1 (Low)		
Randall	-1.10	1 Year

Participant/Quartile	Difference	Time in Algebra PD
Marie	-0.17	2 Years
Natasha	+0.03	1 Year
Blake	+0.19	2 Years
Quartile 2		
Chloe	+0.50	2 Years
Kamace	+0.64	2 Years
Sharon	+0.64	2 Years
Quartile 3		
Aria	+0.75	2 Years
Elena	+1.03	2 Years
Ofelia	+1.31	1 Year
Quartile 4 (High)		
Gino	+1.50	2 Years
Fatima	+1.64	2 Years
Deanne	+1.80	2 Years
Henry	+3.47	2 Years

Note. PD = professional development. The difference represents subtracting the post-survey mean from the pre-survey mean. A negative symbol represents a decline in collaborative interaction quality, while a positive symbol represents an increase in interaction quality.

Table 7

Randomized Quartiles of Participant Difference of Pre- and Post-Teamwork Quality Survey & Time in Program

Participant/Quartile		Difference	Time in Algebra PD
Quartile 1 (Low)			
Randall		-1.10	1 Year
Blake	(Team 2)	+0.19	2 Years
Marie	(Team 2)	-0.17	2 Years
Natasha		+0.03	1 Year
Quartile 2			
Kamace	(Team 4)	+0.64	2 Years
Chloe	(Team 2)	+0.50	2 Years
Sharon	(Team 2)	+0.64	2 Years

Participant/Quartile		Difference	Time in Algebra PD
Quartile 3			
Ofelia		+1.31	1 Year
Aria		+0.75	2 Years
Elena	(Team 3)	+1.03	2 Years
Quartile 4 (High)			
Gino	(Team 4)	+1.50	2 Years
Henry		+3.47	2 Years
Deanne	(Team 4)	+1.80	2 Years
Fatima		+1.64	2 Years

Note. PD = professional development. Italics indicate inclusion in the study; the difference represents subtracting the post-survey mean from the pre-survey mean. A negative symbol represents a decline in collaborative interaction quality while a positive symbol represents an increase in interaction quality.

The participants selected for this study reflected demographic variety and experience. All participants taught eighth grade and received certification through alternative or traditional university programs (see Table 8).

Table 8

Participant Demographics

Name	Ethnicity[a]	Gender	Subject	Grade Level	Teaching Experience	Certification	Cert. Process
Marie	Other	Female	Math	8	4 Years	Mathematics 4-8 & 8-12	Alt. Cert.
Blake	White	Male	Math/ Algebra	8	1 Year	Mathematics 7-12	Alt. Cert.
Chloe	White	Female	Math	8	1 Year	Generalist EC-6 & 4-8	University
Kamace	African American	Female	Math	8	12 Years	Mathematics 4-8 & 8-12	Alt. Cert.
Sharon	White	Female	Math	8	26 Years	Elementary Mathematics 1-8	University
Elena	White	Female	Math/ Algebra	8	3 Years	Mathematics 4-8	Alt. Cert.

Name	Ethnicity[a]	Gender	Subject	Grade Level	Teaching Experience	Certification	Cert. Process
Gino	Hispanic	Male	Math/ Pre-Alg.	8	5 Years	Mathematics 4-8	Alt. Cert.
Deanne	White	Female	Math	8	10 Years	Mathematics 4-8 & 7-12	University

Note. Cert. = Certification; Alt. = Alternative; EC = Early Childhood; Pre-Alg. = Pre-Algebra. Demographic information represents first year of algebra PD program. [a]Ethnic nomenclature determined by state designation.

Teamwork Quality Question Analysis

Tables 9-14 present descriptive information of meaningful TWQ survey items to provide insight into participants' responses and how they vary. The information presented in the tables reflects the responses of the participants ($n = 8$). Means and standard deviations of both pre- and post-surveys provided clarity of responses, as well as mean differences to reveal positive or negative movement. The items were divided the six facets of the TWQ and placed in descending order by post-survey mean. The Likert scale used for the TWQ survey included a 6-point scale, with 1 representing *not very well* and 6 representing *extremely well*.

Communication

Communication represented the first facet comprising the construct of team collaboration and described how group members exchanged information. The following section shows analysis of consequential communication items.

Question 6 produced the highest post-survey mean ($M = 5.86$, $SD = .35$), which suggested participants did not sequester important information from one another. This openness of communication remained consistent as the pre-survey mean ($M = 5.50$, $SD = 1.41$) indicated a high level of satisfaction with the level of openness. Although Question 6 increased from pre- to post-survey (i.e., 0.38), the amount was negligible, suggesting participates expressed satisfaction from the beginning of the program to the end. Question 4 supported this claim as the post-survey

mean (*M* = 4.13, *SD* = 1.89) suggested participants operated using a free exchange of information, as opposed to a strict hierarchy of formal communication procedures.

Question 8 revealed a large increase in satisfaction with the timeliness of information, as the pre-survey mean (*M* = 3.75, *SD* = 1.49) increased in comparison to the post-survey mean (*M* = 5.00, *SD* = 1.41). The mean increase suggested this specific limitation decreased over time. The overall increase in the communication facet of 0.80 may have indicated the process of information exchange offered in the lesson study process allowed for informal and open communication once members negotiated geographic limitations (see Table 9).

Table 9

Communication Descriptive Information by Pre- and Post-Survey Item

Communication Items	Pre/Post	*M*	*SD*	*M* Diff.
6. Important information was kept away from other team members in certain situations.	Pre	5.50	1.41	+0.38
	Post	5.86	0.35	
7. In our team there were conflicts regarding the openness of the information flow.	Pre	4.88	1.81	+0.88
	Post	5.75	0.46	
5. Project-relevant information was shared openly by all team members.	Pre	4.88	0.99	+0.75
	Post	5.62	0.74	
10. The team members were happy with the usefulness of the information received from other team members.	Pre	4.38	1.19	+0.75
	Post	5.13	1.36	
8. The team members were happy with the timeliness in which they received information from other team members.	Pre	3.75	1.49	+1.25
	Post	5.00	1.41	
9. The team members were happy with the precision of the information received from other team members.	Pre	4.13	1.13	+0.88
	Post	5.00	1.41	
3. The team members communicated mostly directly and personally with each other.	Pre	3.75	1.83	+1.00
	Post	4.75	1.28	
1. There was frequent communication within the team.	Pre	3.13	1.55	+1.16
	Post	4.25	1.16	
2. The team members communicated often in spontaneous meetings, phone conversations, etc.	Pre	3.13	1.73	+1.12
	Post	4.25	1.49	

Communication Items	Pre/Post	M	SD	M Diff.
4. There were mediators through whom much communication was conducted.	Pre	4.25	1.83	-0.13
	Post	4.13	1.89	
Communication Items Total	Pre	4.18		+0.80
	Post	4.98		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

Coordination

Coordination represented the second facet from the TWQ, comprising the construct of team collaboration and described how group members manage efficient task production and time management. The following section shows analysis of consequential coordination items.

Question 14 indicated no change between pre- and post-survey. To explain, the pre-survey mean (M = 4.75, SD = 1.39) remained static when compared to the post-survey mean (M = 4.75, SD = 1.91). This suggested that any personality conflicts teams experienced at the beginning of their lesson study continued throughout the duration of the instruction.

The post-survey mean of Question 13 (M = 5.25, SD = .84) and Question 12 (M = 5.13, SD = .99) indicated members came together to accept goals once they became fully articulated and clear. Interestingly, the large increase between pre- and post-means (i.e., 1.75) for Question 12 implied clear and comprehendible goals developed over time as the pre-survey mean (M = 3.38, SD = 1.77) reflected the third lowest mean of the entire survey. This suggested teachers developed a high level of ownership in creating and enacting lessons over time (see Table 10).

Table 10

Coordination Descriptive Information by Pre- and Post-Survey Item

Coordination Items	Pre/Post	*M*	*SD*	*M* Diff.
13. The goals for subtasks were accepted by all team members.	Pre	4.63	1.06	+0.63
	Post	5.25	0.89	
12. There were clear and fully comprehended goals for subtasks within our team.	Pre	3.38	1.77	+1.75
	Post	5.13	0.99	
11. The work done on subtasks within the project was closely harmonized.	Pre	4.00	1.85	+0.88
	Post	4.88	1.36	
14. There were conflicting interests in our team regarding subtasks/subgoals.	Pre	4.75	1.39	0.00
	Post	4.75	1.91	
Coordination Items Total	Pre	4.19		+0.81
	Post	5.00		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

Balance of Member Contributions

The balance of member contributions represented the third facet from the TWQ, comprising the construct of team collaboration and described equal contribution of knowledge and ideas. The following section shows analysis of consequential balance of member contributions items.

The balance of member contributions facet from the TWQ exhibited less overall growth (i.e., .54) from pre-survey mean (*M* = 4.71) to post-survey mean (*M* = 5.25), when compared to the other facets. This suggested the balance of contribution met participants' expectations throughout the duration of the lesson study because all three questions demonstrated the exact same post-survey mean (*M* = 5.25). The largest mean growth (i.e., 1.0) occurred with Question 15; thus, the passage of time and ability to interact with others allowed group members to learn to recognize other's strengths and weaknesses. Additionally, Question 17 demonstrated

an imbalance of member contributions and may not reflect a substantial cause of conflict among members (see Table 11).

Table 11

Balance of Member Contributions Descriptive Information by Pre- and Post-Survey Item

Balance of Member Contributions Items	Pre/Post	*M*	*SD*	*M* Diff.
15. The team recognized the specific potentials (strengths and weaknesses) of individual team members.	Pre	4.25	1.39	+1.00
	Post	5.25	0.89	
16. The team members were contributing to the achievement of the team's goals in accordance with their specific potential.	Pre	4.50	1.31	+0.75
	Post	5.25	0.89	
17. Imbalance of members' contributions caused conflicts in our team.	Pre	5.38	1.41	-0.13
	Post	5.25	1.49	
Balance of Member Contributions Items Total	Pre	4.71		+0.54
	Post	5.25		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

Mutual Support

Mutual support represented the fourth facet from the TWQ, comprising the construct of team collaboration and described the level of member cooperation versus competition. The following section shows analysis of mutual support items.

Question 22 reflected a high post-survey mean ($M = 5.50$, $SD = .76$) and level of improvement (i.e., 1.25) compared to the pre-survey mean ($M = 4.25$, $SD = 4.25$). As teachers discussed ideas with each other, they developed lessons greater than individual ideas. Moreover, Question 18 ($M = 5.50$, $SD = .76$) and Question 23 ($M = 5.50$, $SD = .76$) reported high post-survey means signifying a willingness to support one another in reaching consensus with important ideas.

Question 19 centered on disagreements and the group's ability to resolve conflict. Question 19 reported a post-survey mean ($M = 5.13$, $SD = 1.13$) that reflected a noteworthy

increase (i.e., 1.0) in relation to the pre-survey mean ($M = 4.13$, $SD = 1.73$). This implied groups learned to manage their conflicts over time; however, Question 19 maintained the lowest post-survey mean suggesting conflict resolution was the lowest of all mutual support questions (see Table 12).

Table 12

Mutual Support Descriptive Information by Pre- and Post-Survey Item

Mutual Support Items	Pre/Post	*M*	*SD*	*M* Diff.
18. The team members helped and supported each other as best they could.	Pre	4.50	1.69	+1.00
	Post	5.50	0.76	
22. Suggestions and contributions of team members were discussed and further developed.	Pre	4.25	1.91	+1.25
	Post	5.50	0.76	
23. Our team was able to reach consensus regarding important issues.	Pre	4.25	1.91	+0.75
	Post	5.50	0.76	
21. Suggestions and contributions of team members were respected.	Pre	4.50	1.77	+0.88
	Post	5.38	0.92	
20. Discussions and controversies were conducted constructively.	Pre	4.38	1.60	+0.88
	Post	5.25	0.89	
19. If conflicts came up, they were easily and quickly resolved.	Pre	4.13	1.73	+1.00
	Post	5.13	1.13	
Mutual Support Items Total	Pre	4.42		+0.96
	Post	5.38		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

Effort

Effort represented the fifth facet from the TWQ, comprising the construct of team collaboration and described the level of energy each team member contributed to achieving the group's common goal. The following section shows analysis of important effort items.

The post-mean survey results for Question 24 ($M = 5.38$, $SD = .92$) and Question 26 ($M = 5.13$, $SD = .99$) signified group members produced satisfactory effort when planning and

developing lessons and enacting the lesson study process. These questions produced the same

level of improvement (i.e., 1.25) based on the difference between pre- and post-mean

differences. This suggested that as teams grew and progressed, participants internalized the value

of their learning, thus increasing their willingness to invest in the project. Additionally,

Question 27 (*M* = 5.13, *SD* = 1.25) implied the amount of exertion each team member made in

achieving the common goal did not spark or cause conflicts (see Table 13).

Table 13

Effort Support Descriptive Information by Pre- and Post-Survey Item

Effort Support Items	Pre/Post	*M*	*SD*	*M* Diff.
24. Every team member fully pushed the project.	Pre	4.13	1.73	+1.25
	Post	5.38	0.92	
26. Our team put much effort into the project.	Pre	3.88	1.81	+1.25
	Post	5.13	0.99	
27. There were conflicts regarding the effort that team members put into the project.	Pre	5.38	0.92	-0.27
	Post	5.13	1.25	
25. Every team member made the project their highest priority.	Pre	3.75	1.58	+1.00
	Post	4.75	1.28	
Effort Support Items Total	Pre	4.28		+0.81
	Post	5.09		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

Cohesion

Cohesion represented the sixth facet from the TWQ, comprising the construct of team

collaboration and described the sense of perceived group togetherness and belonging. The

following section shows analysis of meaningful cohesion items.

After examining post-survey means for Question 29 (*M* = 5.88, *SD* = .35) and

Question 33 (*M* = 5.50, *SD* = 1.07), it became evident participants reported experiencing few

meaningful conflicts in their groups, in addition to demonstrating an elevated commitment to

their learning. The third highest-scoring question, Question 34, indicated participants felt an

acceptable level of togetherness due to the post-survey mean ($M = 5.38$, $SD = 1.06$), which

increased over time (i.e., .63). These questions reinforced the value of collaboration as the

participants viewed working with others as worthwhile.

Furthermore, Questions 28, 30, and 31 suggested participants perceived their lesson study

learning as useful. For example, Question 28 illustrated a high post-survey mean ($M = 5.25$,

$SD = .89$) proposing participants felt value in their learning at the end of the program. However,

the pre-survey mean of Question 28 ($M = 5.13$, $SD = 1.13$) similarly suggested teachers viewed

their participation in lesson study as having worth when they began the program. The modest

increase between pre- and post-means (i.e., .13) revealed the process of lesson study allowed

subjects to maintain initial high levels of enthusiasm throughout the program despite minor

barriers or frustrations. Moreover, Question 30 showed the largest increase between pre- and

post-survey means (i.e., 1.25), which demonstrated commitment to learning. The post-survey

mean ($M = 5.25$, $SD = 1.39$) of Question 31 displayed the importance of learning according to

the participants (see Table 14).

Table 14

Cohesion Descriptive Information by Pre- and Post-Survey Item

Cohesion Items	Pre/Post	*M*	*SD*	*M* Diff.
29. The team did not see anything special in this project.	Pre	5.38	1.06	+0.50
	Post	5.88	0.35	
33. There were many personal conflicts in our team.	Pre	5.13	1.46	+0.38
	Post	5.50	1.07	
34. Our team was sticking together.	Pre	4.75	1.39	+0.63
	Post	5.38	1.06	

Cohesion Items	Pre/Post	*M*	*SD*	*M* Diff.
36. Every team member felt responsible for maintaining and protecting the team.	Pre	4.25	1.75	+1.13
	Post	5.38	0.74	
28. It was important to the members of our team to be part of this project.	Pre	5.13	1.13	+0.13
	Post	5.25	0.89	
31. The project was important to our team.	Pre	4.50	1.20	+0.75
	Post	5.25	1.39	
35. The members or our team felt proud to be part of the team.	Pre	4.13	1.73	+1.13
	Post	5.25	1.16	
30. The team members were strongly attached to this project.	Pre	3.88	1.25	+1.25
	Post	5.13	1.36	
32. All members were fully integrated in our team.	Pre	4.38	1.69	+0.63
	Post	5.00	1.41	
Cohesion Items Total	Pre	4.61		+0.72
	Post	5.33		

Note. Pre/Post = Pre- and Post-Survey; Diff. = Difference.

The eight participants selected for this study demonstrated a range of interaction quality according to the TWQ survey. This range provided information necessary to facilitate the maximum variation sampling method (see Table 15).

Table 15

Pre- and Post-Survey Score Difference by Facet

Name	Communication	Coordination	Balance of Member Contributions	Mutual Support	Effort	Cohesion
Marie	+0.10	-1.25	0.00	0.00	-0.92	-0.03
Blake	+0.40	-0.25	+0.33	0.00	0.00	+0.09
Chloe	+0.70	+2.25	0.00	+0.16	-0.25	-0.20
Kamace	+0.60	+1.00	-0.34	+2.16	0.00	+0.11
Sharon	+1.30	+0.75	+0.33	+0.33	+1.00	-0.68
Elena	+1.10	+1.00	+1.00	+1.17	+1.00	+0.89
Gino	+0.90	+1.50	+1.67	+1.67	+2.00	+0.14
Deanne	+1.40	+1.50	+1.33	+2.17	+1.75	+2.21

Name	Communication	Coordination	Balance of Member Contributions	Mutual Support	Effort	Cohesion
Mean Increase	+0.81	+0.81	+0.54	+0.96	+0.57	+0.32

Data Collection Procedures

After randomization, I emailed the first two participants in each quartile inviting them to participant in the research study on December 15, 2018. After waiting over 30 days, no one had responded to the invitations. As a result, I reviewed incentive studies and concluded many researchers have explored incentives to increase mailed-survey responses (King, Pealer, & Bernard, 2001); however, there was an exceptionally low number of researchers who examined incentives promoting participation in qualitative research (Clark, 2010; Head, 2009; Islam & Tanasiuk, 2013; Kelly, Margolis, McCormack, LeBaron, & Chowdhury, 2017). The only literature informing qualitative incentives originated from Kelly and colleagues (2017). Their study suggested a cash incentive of $50.00 provided the most incentive for a 90-minute face-to-face qualitative interview, when compared to higher or lower amounts. Additionally, the authors concluded a noncash prize drawing did not incentivize participants. Based on this study, I offered each subject a $50.00 cash incentive to increase interest and improve the response rate. From an ethical standpoint, I did not consider the teachers a vulnerable population, so the incentive would not create an unreasonable inducement to participate in a hazardous research study.

After receiving Institutional Review Board authorization, I emailed a second round of invitations and six subjects agreed to participate. I reached out a second time via email to the three non-responsive participants, but they never answered. As a result, I emailed the participants who occupied the third spot in each quartile, inviting them to participate and two responded favorably. As a result, there were two participants in each quartile who agreed to join the study.

However, during the interview process, one participant did not allow audio recording, so I took

notes. Unfortunately, the quality and depth of the notes taken during the interview did not offer a

rich articulation of the participant's experience when compared to the audio transcripts. For

example, the transcripts derived from audio averaged 19 pages in length, but the notes did not

exceed two pages. Due to the lack of depth collected via notes, I recruited one more participant,

who agreed to an audio recording, and I elected to remove the participant who only allowed

notes. This adjustment caused a slight imbalance in quartiles, as three participants represented

Quartile 2 and one person represented Quartile 3; however, this adjustment resulted in the

recruitment of eight participants who each completed two years of the algebra PD program and

participated in three separate lesson studies. By securing eight participants, I met the criteria for

data saturation.

Once I received emails from the teachers agreeing to participate in the semistructured

interview, I arranged to meet with the participants at their campus. All interviews lasted from 45

minutes to one hour and were audio recorded. Five were conducted face-to-face; the locations

included the teacher's classroom for four teachers and a public library for one teacher. All

participants reflected a calm and cooperative demeanor throughout the interview process. I

remained aware of positionality issues and attempt to equalize any power differentials by

establishing rapport with each participant at the beginning of each interview. Before the

interview, I briefly described the nature of the research and reviewed the information in the

consent letter emphasizing confidentiality, the use of pseudonyms in reports/publications, and

the voluntarily nature of the interview. Interviews commenced after the subjects read and signed

the letter. The remaining three interviews were conducted via telephone due to geographic

limitations and timing. For instance, two subjects had moved to a different part of the state, and

one subject, due to Spring Break, preferred to communicate via telephone as opposed to meeting in a public area. As with the face-to-face interviews, I explained the information in the consent letter before the telephone interviews and asked for permission to audio record the telephone call. Additionally, each subject received a scanned copy of the consent letter via email before the interview. After the interviews, each participant signed and returned the consent letter via email at their convenience. There were no substantial interruptions or ambient noise during the interviews, and both face-to-face and telephone interviews produced quality audio resulting in accurate transcriptions.

In addition to the semi-structured interviews, participants completed 20 written reflections during Year 2 of participation in the algebra PD. Reflections 2, 3, 6, and 7 were used in this study, as well as the TWQ survey (see Table 16).

Table 16

Timeline of the Data Collection Sources

	2018						2019		
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Written Reflections (Appendix A)			6	2	3		7		
TWQ Survey			Pre				Post		
Semi-Structured Interviews (Table 17)								Gino Marie Chloe Kamace	Elena Blake Deanne Sharon

Note: Information in the table describes the data collection timeline. Information in parentheses is where to find more information on this topic.

Expert Review

Before the interview process began, I invited two experts to review the semi-structured interview protocol to solicit feedback on the quality, length, and substance of the questions. One

expert had over 20 years of experience as a superintendent, had successfully led a large suburban district, and had received notoriety as a progressive leader. The second reviewer, an associate professor of education, specialized in mathematics instruction and in-service teacher PD. The first expert reviewed the protocol and concluded the number of questions appropriately supported a 45-60 minute interview but reinforced the use of the prompts to extend the respondent's answers, if necessary. The second expert emphasized the difficulty of exploring autonomy as a construct and recommended adding, "Explain your level of comfort or discomfort when offering ideas during the LSOA process" to increase information related to autonomy.

Additionally, the second expert suggested revising the order of questions to include relatedness before autonomy to produce a better transition and flow. Lastly, the second expert considered the introduction questions appropriate because they promoted participant self-reflection and considered the final questions appropriate to elicit quality responses related to motivation (see Table 17).

Table 17

Semi-Structured Interview Questions Used in Study

Research Question	Interview Questions

Introduction Questions	1. How long have you been teaching at this school?
	    Probe: In what capacity have you worked here?
	    Probe: What classes and grade level are you currently teaching?
	    Probe: What classes and grade levels have you taught in the last two years?
	    Probe: How long have you been teaching this content?
	2. Can you briefly describe your certification process?
	    Probe: Alternative certification or university certification.
	    Probe: What type of teacher certification do you currently have?
	3. Why did you decide to become a math teacher?
	4. Why did you volunteer to participate in the algebra PD program?
	    Probe: What did you hope to gain?

SQ1. How do teachers experience competence when	5. Was there anything about the LSOA cycle that gave you confidence? *Probe*: Were some stages more impactful than others? 6. Was there anything about LSOA cycle that made you feel successful?

Research Question	Interview Questions
participating in LSOA?	*Probe*: How did these feelings impact what you did or did not do in your classroom when trying new instructional strategies? 7. Was there anything about LSOA that reduced your confidence or success?

SQ2. How do teachers experience relatedness when participating in LSOA?	8. What do you think about the collaborative process of the LSOA cycle?
	    Probe: What do you like about it?
	    Probe: What do you dislike about it?
	9. Describe your group's dynamic?
	    Probe: How did these relationships influence your learning?
	    Probe: How did these relationships influence the learning of others?

SQ3. How do teachers experience autonomy when participating in LSOA?	10. Explain your level of comfort or discomfort when offering ideas in the research, design, and revision of the lesson.
	11. Was there any part of the LSOA process that gave you an element of choice?
	    Probe: How does choice affect your motivation?
	12. Was there any part of the LSOA process that did not give you an element of choice?
	    Probe: How did this make you feel?

RQ2. In what ways does LSOA connect with teacher motivation?	13. Was there anything that helped you value or gave you ownership of your new learning from LSOA?
	14. Was there anything that motivated you to implement new strategies learned from your LSOA rounds in your classroom?
	15. Was there anything that discouraged your learning or motivation to use new strategies?
	16. Was there any change in your motivation to implement new strategies in your classroom over time?
	    Probe: If they did change, explain why.
	    Probe: If they did not change, explain why.
	17. What do teachers need (specifically) to help them become and stay motivated to participate in professional development and implement new instructional strategies into their classrooms?

Note. RQ = Research Question; SQ = Subquestion. Table shows the questions used in study. Researcher read questions out loud to each participant verbatim.

Data Analysis

The data analysis began by transcribing the audio recordings. I used a transcription service (rev.com) to perform this function. To ensure accuracy, I listened to the audio recording while viewing the transcripts. As a result, I made minor corrections, which mostly addressed the spelling of proper nouns. I confirmed accuracy, through member checking, by asking participants to review their transcripts. Sharon, Elena, Blake, and Chloe responded, with two

reporting no issues and two reporting minor spelling errors. Overall, the transcripts reflected a high degree of accuracy.

Thematic Analysis

The current study used three forms of data and three approaches to data analysis. The main data source included eight semi-structured interviews and I used thematic analysis (Braun & Clark, 2006) to develop main themes composed of subthemes. I conducted the thematic analysis by reading each transcript without writing notes, annotations, or codes. After the initial reading, I drafted an initial-impression memo, which summarized the participants' overall perceptions of their LSOA experience. The second phase included writing descriptions of the underlying meaning of sentences and paragraphs of information related to the research questions. The purpose of this coding enabled the development of latent, as opposed to semantic themes. The next phase included the creation of initial codes that complemented the latent descriptions, and I performed this function twice. The second coding resulted in the addition of four new codes and confirmed the original codes resulting in a total of 50 subthemes. The theme review resulted in combining similar subthemes to create a total of 22. These subthemes were refined to produce a total of seven themes. I performed four major coding/thematic reviews, lasting 8 days, until the data failed to produce new information; thus reaching the data saturation point. The coding process produced 22 subthemes contained under seven overarching, or main, themes (see Appendix D).

Content Analysis

The second data source included four written reflections each from the eight teachers and content analysis (Graneheim & Lundman, 2004) was used to analyze the results. Like the thematic analysis procedures, I read the responses to facilitate data familiarization and drafted

initial-impression memos. This resulted in a general summary of each teacher's perceptions, which included an appreciation of learning new pedagogy. The general summaries gave me an understanding of each teacher's written reflections. I created meaning units composed of individual sentences or clusters of sentences expressing similar information. Next, I summarized the meaning units and wrote interpretations of the underlying meaning of the participant's words. This process was repeated a second time and no changes were made. I then assigned subthemes and themes to capture and define the important patterns and information expressed by the participants.

Triangulation

Triangulation is a process by which researchers use (a) various sources of information, (b) perspectives, or (c) methods to draw research conclusions (Yin, 2018). By using multiple sources of information, the credibility of a study's conclusion increases. As a result, triangulation enhances the validity of results by reducing researcher bias and method deficiencies. (Casey & Murphy, 2009; Farmer, Robinson, Elliott, & Eyles, 2006; Meijer, Verloop, & Beijaard, 2002; Renz, Carrington, & Badger, 2018). Yin (2018) also warns that one source of information for a case study is inadequate. Therefore, using multiple sources of data inherently promotes the foundation of case study by enhancing information related to how individuals perceive experiences within a certain context. Moreover, the inclusion of multidimensional perspectives can allow the researcher to better understand a participant's context, thus increasing depth of understanding. This study employed the following strategies to meet Yin's expectation of evidence variety.

The triangulation data in this study included: (a) semi-structured interviews, (b) written reflections, and (c) TWQ survey results (Hoegl & Gemuenden, 2001). I used (a) thematic

analysis to inductively analyze semi-structured interview transcripts (Braun & Clarke, 2006),

(b) content analysis to analyze the written reflections (Graneheim & Lundman, 2004), and

(c) paired sample *t*-tests to evaluate the TWQ survey (Pallant, 2016). The triangulation process

used sequential data collection (Casey & Murphy, 2009) and a procedural approach (i.e.,

documenting steps describing the data comparison process; Meijer et al., 2002). Both

methodological (i.e., using both qualitative and quantitative data) and data triangulation (i.e., two

forms of qualitative data sources) underpin the current study's procedure (Patton, 1999). This

triangulation process supported transparency. as well as replicability.

The following steps described the triangulation process utilized in this study (Farmer et

al., 2006). The first step included developing themes from interviews and reflections, in addition

to writing conclusions/implications based on the *t*-test statistics results. The second step involved

placing the themes and survey conclusions onto an evidence-coding matrix. The third step

applied evidence codes to each theme/survey conclusion, which included (a) convergence,

(b) complementary, and (c) dissonance (Erzberger & Prein, 1997). Lastly, the fourth and final

step involved reporting the results by level or priority on a table.

The evidence codes for the matrix included the following definitions. *Convergence (2)*

represented convergence when themes or conclusions/implications indicated complete agreement

between two data sources. Code *convergence (3)* indicated convergence when themes or

conclusions/implications reflected complete agreement between three data sources. *Complete*

convergence was defined as multiple forms of corroborated evidence that defend a unique reality

(Erzberger & Prein, 1997). Additionally, I considered themes and survey

conclusions/implications that used different vocabulary to be in agreement if the underlying

meanings were similar within a similar context (Patton, 1999). To illustrate, if one teacher

reported they were motivated when they saw their students achieve and another teacher stated

they became excited when they witnessed their students having fun while learning, I considered

those two themes to represent convergence agreement.

Complementary evidence was recorded when one data source produced an answer to the

research question that did not converge with another data source. *Complementary* was defined as

information that did not converge with other data but supplemented the research question by

adding pertinent information (Erzberger & Prein, 1997). For example, if a semi-structured

interview and a journal entry revealed teachers liked approachable principals, the evidence was

convergent because two forms of data collection exposed approachability as a beneficial

principal characteristic. Conversely, if a semi-structured interview revealed approachability as a

positive principal characteristic and the journal entry revealed honesty as a positive principal

characteristic, the evidence was considered complementary because the two characteristics do

not converge but added to total understanding. The last category was *dissonance*, which referred

to results demonstrating disagreement (Erzberger & Prein, 1997). For example, if one teacher

revealed they became motivated when working for a friendly principal and another teacher

reported they became motivated when working for an unfriendly principal, their conflicting

responses demonstrated dissonance.

The fourth and final step involved reporting the results by level or priority. This process

began by documenting Convergence (3) results, which was the convergence of evidence from

three sources of evidence. These conclusions demonstrated the most credibility due to their high

level of convergence (Yin, 2018). The next step included documenting Convergence (2) results,

followed by recording complementary results. As discussed earlier, I considered Complementary

results informative because they added emphasis to the overall understanding of the research

question. The last step included verifying any results that included Dissonance. In addition to this table, I constructed frequency charts to indicate the number of times a participant referred to a subtheme.

Trustworthiness

Trustworthiness was addressed by using specific strategies to address internal validity, reliability, and external validity. Internal validity focuses on the level of confidence in the legitimacy of the results (Hesse-Biber, 2017). To address internal validity, Merriam (1998) suggests the following six strategies: (a) triangulation, (b) member checks, (c) long-term observation, (d) peer examination, (e) participatory research, and (f) addressing researcher bias. This study addressed four out of the six recommended strategies. To illustrate, I included the use of methodological and data triangulation (Patton, 1999) from a procedural perspective (Meijer et al., 2002) in a sequential manner (Casey & Murphy, 2009). The use of these triangulation strategies increased the confirmation of findings when compared to using only one source of data that ignores any attempt at triangulation (Yin, 2018). Member checking was addressed by emailing transcripts to each participant to confirm accurate meanings. Additionally, data collection for this study began on July 2017 and ended on March 2019. This period extends well over a year (i.e., 17 months), thus providing data over a wide-ranging time period. Lastly, researcher bias was addressed with a positionality statement, and a plan to analyze and report data with a reflexive mentality throughout the duration of the study. However, due to limitations of resources and limited authority in the algebra PD program, peer examination and participatory research were not feasible.

The second trustworthy strategy, reliability, focuses on the dependability and consistency of the results, as well as the extent to which other researchers can replicate the study process

(Hesse-Biber, 2017). Merriam (1998) recommends three strategies to increase the concept of reliability in the minds of readers including: (a) the investigator's position, (b) triangulation, and (c) an audit trail. The investigator's position was addressed by fully explaining the assumptions and theories of the study in the literature review and the methodology section.

The last trustworthy strategy, external validity, refers to the generalizability of a study and is very much associated with quantitative research (Hesse-Biber, 2017). However, Firestone (1993) argues *transfer*, based on a case-to-case basis, replaces the concept of generalizability in qualitative studies. Specifically, Firestone (1993) states, "It is the reader who has to ask, what is there in this study that I can apply to my own situation, and what clearly does not apply?" (as cited in Merriam, 1998, p. 211). This suggests consumers of research should decide if the results of a qualitative study apply to their unique situation, thus supporting the transfer of results to their context. As a result, it is the responsibility of the researcher to provide detailed descriptions of their study by providing the information necessary to allow readers to judge for themselves the amount of fit between the research and their own situation.

Merriam (1998) provides three suggestions for facilitating qualitative external validity by describing the following approaches: (a) thick description, (b) typical or model category, and (c) multisite design. This dissertation study provided a thick description by explaining why and how the participants were selected. In addition, the study described the participants, the algebra PD program, and the social context of the participants' teaching assignments and schools in detail. The study provided ample detail to enable readers to assess the amount of fit between their unique situation and the research, thus facilitating case-to-case transfer. However, this study cannot articulate a typical or model category or a multisite design because LSOA is an emerging PD approach.

Limitations

The limitations identified for the current study were (a) generalization, (b) culture, and (c) voluntary teacher participation. To begin, the results of this study are not generalizable; therefore, readers may not automatically infer the results will apply to the greater population of teachers (Hesse-Biber, 2017). However, generalization from the quantitative perspective is not the point of this study. Instead, the aim of the current study provided insight into the lived experienced of teachers who participated in a LSOA learning process. The results can inform the practice of public school administrators from a general sense and promote transfer—if applicable (Firestone, 1993). Although this research is not generalizable, readers may be able to transfer the interpretation of results; however, it is important to judge context before making this decision. To advance this idea, Onwuegbuzie and Leech (2007) asserted "generalizations of any interpretations to another context should be made after being adequately cognizant of the new context and how this new context differs from the context from which the interpretations were generated" (p. 118). Additionally, Bryman (2012) emphasized, "Lincoln and Guba argue that a thick description provides others with what they refer to as a database for making judgements about the possible transferability of findings to other milieu" (p. 392). Both authors confirm Firestone's (1993) conceptualization of case-to-case transfer, suggesting qualitative results can guide practical application if the context between the research and the school/staff are comparable. This decision lies in the judgement of the readers; however, reader judgement increases when the researcher provides detailed descriptions (thick), thus providing enough information to allow the reader to make an accurate judgement. Taken together, these authors support my assertion that public school administrators can transfer my study results to their specific campuses if there are similarities between contexts.

The second limitation is culture. For example, LSOA researchers Kadroon and Inprasitha (2013) argue culture contributes greatly to teacher epistemological beliefs. They define *teacher epistemological beliefs* as the values and beliefs that underlie how teachers should teach based on how students learn. To illustrate, if teachers believe students learn from lectures and notes they may prioritize lecture-type pedagogies. Conversely, if teachers believe students learn from discovering information on their own, they may prioritize inquiry-based pedagogies. Kadroon and Inprasitha (2013) insist these epistemological beliefs develop because of cultural norms. Moreover, when teachers internalize these cultural norms through various life experiences, they make pedagogical teaching decisions that align with their norms. As a result, these cultural norms are powerful in guiding teacher actions. While I agree culture impacts teacher epistemological development, exploring the cultural impact on teacher interaction and the epistemological change process exceeds the scope of this study. I concur that this topic is worthy of further study but time and resources prevented the inclusion of culture in the current study.

The third limitation is the voluntary versus non-voluntary participation of the teachers. Every teacher in this study volunteered to participate, which could indicate a higher level of motivation to learn in comparison to mandated participation (Fishman, Marx, Best, & Revital, 2003). According to Glickman's model of supervision, teachers have high or low levels of commitment and abstraction (Kemerer & Crain, 2012). *Commitment* refers to the level of ownership in promoting student achievement and advocating for students. Teachers with high levels of commitment are willing to learn new strategies and dedicate more time to promoting student success. Furthermore, *abstraction* refers to the teacher's level of awareness. This awareness includes being reflective and having the ability to make instructional adjustments based on student need. This concept also includes having a wide-ranging inventory of

instructional strategies to use with students. As mentioned, the teachers in this study volunteered to participate, so readers can reasonably assume the teachers had a higher level of commitment in comparison to non-volunteer teachers. Additionally, readers could argue the teachers who participated in the algebra PD had a lower level of abstraction, thus motivating them to learn more teaching techniques. As a result, this study does not apply to unmotivated teachers who have a low level of commitment. Therefore, I limit this study to explaining the experiences of motivated teachers who participated in a PD learning opportunity.

In this chapter, I discussed how single case study research design can answer the research questions that unpinned the current study, as I explored how teachers experienced motivation in the context of LSOA. Interviewing eight participants met the data saturation requirement and trustworthiness was addressed by triangulating data from semi-structured interviews, written reflections, and the TWQ survey. This data was analyzed using thematic analysis, content analysis, and paired sample *t*-test respectively.

The next chapter reports the findings from collected data. The chapter continues by presenting convergent, complementary, and dissonant results on the evidence coding matrix and ends with a final summary.

CHAPTER 4

RESULTS

The purpose of the current study was to examine the intersection of teacher motivation

and the professional development (PD) tool of lesson study with open approach LSOA to

describe how mathematics teachers perceive social and contextual factors that may impact their

autonomous motivation when choosing to enact or reject the implementation of newly learned

pedagogy. The research questions (RQs), along with subquestions (SQs) for RQ1, guiding this

study included:

- RQ1. How do teachers perceive the motivational contextual factors offered by lesson study with open approach?

  o SQ1. How do teachers experience competence when participating in LSOA?

  o SQ2. How do teachers experience relatedness when participating in LSOA?

  o SQ3. How do teachers experience autonomy when participating in LSOA?

- RQ2. In what ways does lesson study with open approach connect with teacher motivation?

In this chapter, I present the triangulation results and a detailed description of the

findings. The chapter ends with a conclusion that summarizes the findings.

Evidence Coding Matrix

Table 18 shows the total themes and subthemes generated from the semi-structured

interviews, written reflections, and Teamwork Quality survey (TWQ) interpretations. I applied

these results to the evidence coding matrix to demonstrate the degree of triangulation.

Convergence from three sources characterized the strongest evidence, followed by convergence

from two sources, ending with complementary evidence. There were no examples of dissonance.

Table 18

Evidence Coding Matrix

		Evidence Code			
		Convergence (3)	Convergence (2)	Complementary	Dissonance
Competence					
Emerging Proficiency	Collective Validation			X	
	Pedagogical Substantiation			X	
	Acute Feedback			X	
	Pedagogical Affirmation			X	
Apprehension	Lack of Communication		X		
	Vulnerability			X	
Relatedness					
Synergy	Meaning Negotiation		X		
	Collective Solidarity		X		
Minor Barriers	Collective Rejection			X	
	Time Consuming			X	
	Limited Experience			X	
	Overwhelming		X		
Interpersonal Dynamics	Positive Interpersonal Dynamics	X			
	Contentious Interpersonal Dynamics	X			
	Meaningful Collaboration			X	
	Conflict Apprehension			X	
Autonomy					
Volition	Growth Preference			X	
	Voluntary Participation			X	
	Ownership		X		
Motivation					
Internalization	Value Recognition		X		
	Student Response		X		
	Epistemological Shift		X		

Note. Convergence (3) represents three data sources confirming evidence; Convergence (2) represents two data sources confirming evidence; Complementary represents data collected from one source; Dissonance reflects conflicting data.

Findings Related to Research Question 1

The first research question, RQ1 (i.e., How do teachers perceive the motivational contextual factors offered by lesson study with open approach?), sought to understand how teachers perceived social and environmental factors uniquely associated with the lesson study process that influenced teacher motivation.

Research Question 1–Subquestion 1: How do teachers experience competence when participating in LSOA?

Three sub questions informed RQ1, beginning with asking how teachers might experience competence when participating in LSOA. Competence includes feeling like one had a fair opportunity to successfully achieve personally meaningful objectives (Ryan & Deci, 2017). This encompassed believing one has the (a) skills, (b) opportunity, and (c) ability to have a causal effect on an object or action leading to feelings of success. Competence involved epistemic desires to successfully obtain new knowledge leading to goal attainment and feelings of achievement. Additionally, positive feedback, feelings of mastery, and effectiveness increase perceptions of competence. The results of the semi-structured interviews, incorporating competence, included two themes and six subthemes (see Table 19).

Table 19

Competence Themes and Subthemes from Semi-Structured Interviews

Theme	Subtheme Informing Theme
I. Emerging Proficiency – trusting new pedagogy and understanding how to enact it in their unique classroom	• Collective Validation – increased confidence due to approval or admiration from other teachers • Pedagogical Substantiation – teacher personally observes evidence supporting pedagogical effectiveness • Acute Feedback – receiving focused and specific feedback from knowledgeable peers

Theme	Subtheme Informing Theme
	• Pedagogical Affirmation – meeting desire to learn *what* and *how* to teach mathematics
II. Apprehension – feelings leading to reductions in confidence or success when enacting some portion of the lesson study cycle	• Lack of Communication – reduced information exchange leading to perceived decline in group's ability to achieve goals • Vulnerability – fear that peers would perceive one's teaching as inadequate

Note. Information in table represents results from interviews; it does not include information from any other source.

Competence Theme I: Emerging Proficiency (Semi-Structured Interviews)

Based on the thematic analysis of the semi-structured interviews, the theme of emerging proficiency described the teacher's perception of competence. This theme entailed trusting new pedagogy and understanding how to enact it in their own unique classroom settings. The subthemes of collective validation, pedagogical substantiation, acute feedback, and pedagogical affirmation collectively supported the emerging proficiency theme.

• Collective validation, the first subtheme, occurred when various teachers (during any part of the collaborative process) received praise or recognition from others, based on one of their ideas or suggestions related to instruction or teaching. When colleagues validated each other, participants often reported feeling an increase in confidence. For example, Gino stated:

> Those breakout boxes, I saw it. I got an idea of it. I was like, "Okay." I think I got these questions. I think I know how to ask questions. I think I can do this assignment. That was my project that I did and it was very well-received by everybody. That just skyrocketed my confidence. It was like, "okay."

Gino's feelings of competence increased when his lesson study colleagues lauded his breakout-box lesson. His feeling of competence increased when his colleagues recognized the quality of his idea and how it translated into a practical and effective lesson. Additionally, Elena reported:

> I guess, maybe also because of the feedback that I was getting from other people. They were like, "Oh, I really like how you did this, I really like ..." And like I said, being so new I was a little nervous about it. I was like, "Well, maybe I don't know as much, and I wouldn't compare to other teachers, maybe, as well." And then seeing how... Especially

when they would take it back to their own classrooms, some of the things that I tried out, that was really helpful, too. It's like, "Oh, it doesn't work just for my group. It works for a lot of groups, other schools and stuff."

Elena articulated the premise of collective validation well as her insecurity of being a new teacher dissolved as her colleagues recognized her effective instructional techniques to the point of using them in their own classrooms. This greatly increased Elena's competence, as she was fearing an unequal status within her professional peer group.

- Pedagogical substantiation, the second subtheme, refers to a teacher personally observing or experiencing evidence that supports the effectiveness of a new pedagogy or instructional strategy. This subtheme included teachers (a) watching others implement a strategy during the live lesson, (b) witnessing student engagement, or (c) collecting student data revealing student learning or understanding. Pedagogical substantiation essentially provides truth or evidence that an instructional technique or pedagogy works. This creates the perception that the teacher witnessing successful implementation will be capable of replicating the technique. Marie recounted:

> So to release that control to the children to do inquiry-based learning, to me that's a huge shift in teaching style. And so, when we tried it, it was very uncomfortable. But at the same time, I saw what can be possible, and that kind of gave me confidence that yeah, actually it made me uncomfortable, but it actually is doable. They [the students] actually can make certain leaps of judgment. It won't be all of them. But you don't need all of them. So to me, that gave me confidence to try, and it gave me confidence in my children, really.

Marie described her experience with pedagogical substantiation in vivid form. She admitted the inquiry-based pedagogy caused cognitive dissonance due to her behaviorist epistemological orientation. This epistemological conflict provoked tension causing elevated levels of discomfort; however, the ability to see the lesson in action during a live teaching demonstration, with a lesson she co-created, provided a safe space to experience new learning. Witnessing the

effective implementation of the new pedagogy increased her confidence and belief that students

can react favorably to inquiry-based learning. In similar fashion, several other participants

expressed pedagogical substantiation as follows:

> I think if there was something that you saw working in another campus or with other kids
> or something that worked really well in the lesson, then that was a motivation to do it in
> your room because you saw it actually working (Chloe).

> . . . that's part of the enjoyment of the open approach that I really liked, is the fact that
> you can see it in action because that's where I feel like I learn more, is when I can see
> other teachers doing what they do (Elena).

> We practiced enough that the actual techniques were more available, and it did give me
> the confidence to try them out in my classroom (Blake).

These participants communicated the power of pedagogical substantiation as they reported

gaining substantial competence after observing new pedagogies in action. The participants

expressed gaining enthusiasm to use their new strategies when they observed its effectiveness

during the lesson study process.

- Acute feedback described the third subtheme and this concept referred to teachers'

appreciation of quality and nuanced timely feedback to facilitate lesson adjustments before

reteaching. Teachers valued this opportunity, as they rarely have time or resources to make

lesson adjustments based on data collected by others. In addition, they had a keen appreciation of

suggestions for lesson improvement provided by content-knowledgeable peers in a collaborative

setting, all happening in a single day. Gino communicated:

> That's what I loved about it is we tried it third period and then let's try it seventh, and we
> tweaked some stuff. Okay, the recording sheet wasn't the best, so let's tweak it a little bit.
> Let's go run some copies and let's see if this recording sheet helps out. It was cool that
> way, and we just... It's just inspiring, man. It was very inspiring.

Gino appreciated the opportunity to immediately apply highly specific feedback and adjust the

lesson, as well as their own contributions to the lesson study cycle. This allowed the teachers to

make their own decisions based on data collected as a team. They felt like professionals because they helped each other and exchanged specialized knowledge. Instead of telling the person assuming the teacher role to ask better questions, they could write a question or offer a specific way to make an adjustment. Elena exemplified this occurrence when she stated, "Even if I just worded something different [based on feedback] or maybe adjusted the order in which I was teaching something, it made a real big difference." This reflects the power of a subtle change in instruction that prompted an impactful difference that only another mathematics teacher, familiar with the lesson goal and design, could offer. Gino further articulated his appreciation of nuanced feedback by reiterating:

> Traditional administrator feedback is superficial. I mean, again, it's different when your principal observes you. It's different when an area director observes you. It's different. Yeah, they're looking to support and things like that, but sometimes I was feeling they were just checking off boxes. They don't really give me any feedback or they tell me some feedback, but they don't sit down with me, and, [say] this is what you should change.

To be clear, Gino respected his administration and spoke highly of them during the interview; however, his comment was based on his experience, thus specifying lesson study's potential to offer specific or acute feedback. Administrative teaching evaluations produce feedback, but it does not provide real-time feedback designed for immediate implementation. Gino reinforced his point when he stated:

> [During the live lesson] I was asking questions, but the way that I was wording them could sometimes be confusing to the student. I saw that afterwards. It was like, "Okay. I could ask it this way. They're like, Yeah, why don't you ask it this way?" It's the same question essentially, but you want the same answer, but this is the way you can ask it. Maybe the kids will be . . . You're like, Oh, I kind of understand what you're saying now. I think I grew with the questioning of how I ask questions.

This quote exemplified how Gino's peers could offer him specific information on how to phrase his questions. Instead of checking a box suggesting improved questioning, Gino's lesson study

peers provided specific examples on how Gino could adjust his questions. The other teachers were not judging Gino, they were simply trying to help him ask better questions to improve the overall lesson that everyone created. An administrator, during a traditional evaluation, could not perform the same function as a fellow mathematics teacher during a lesson study cycle. This process of receiving acute feedback, with time for immediate application, promoted increases in confidence. Marie supported this claim by stating:

> Because we have certain roles in the group, and one of the roles is to do the actual teaching, and we do it twice. First round, and then we do the debrief, do the modifications or adjustments, and then we do it again. I basically did the second round. And to see it in action and then actually teach the second round, the supposedly improved version, that's pretty awesome. So to me, that gave me the confidence of, "Hey, I actually can do this." You know? And look, they [students] actually did something. It's still confidence. I felt like I could try. It gave me the confidence to try.

The ability to immediately apply focused and specific feedback from other mathematics teachers that produced observable improvements in student understanding created confidence in both the students and the teachers.

- Pedagogical affirmation, the fourth subtheme, described the teacher's desire to understand *what* they were supposed to be doing from a pedagogical standpoint. Teachers expressed interest in understanding how to design lessons with deliberate intent, as well. They wanted to understand the *why* behind strategies, in order to realize the goal behind the learning. Achieving pedagogical affirmation also allowed them to reproduce the strategies on their own. Kamace affirmed this subtheme when she reminds us, "So, I feel like, well, I'm up on current thinking. So, I think we're learning current strategies that are valued throughout education in [algebra PD] that I wouldn't have been exposed to if I hadn't have [participated]." Moreover, Elena emphasized:

> I think going through it the first time, I guess my confidence was and the fact that some of the things ... My ideas weren't as maybe out there as maybe I thought they were or

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wasn't in line with how students actually learn or think. That made me feel more confident that the stuff that I was doing in class, it was reinforcing that what I'm doing is actually pretty good, so I felt good about that.

These teachers expressed a desire to know and understand epistemological truth. Many participants sought to learn the best way to teach mathematics and have confidence in their pedagogical belief. This became apparent as some teachers admitted an insecurity about pedagogical understanding based on their teacher preparation experience. "Being alternative-certification, they're more general with it. I didn't really do math specific, so I was learning it as I was going." This quote explained Gino's perception of inadequate preparation based on his alternative certification process. While he received a degree, he did not take undergraduate education classes specializing in pedagogy. He often referred to his lack of mathematics-specific pedagogical knowledge as a driving force in seeking pedagogical affirmation. Gino endorsed this concept when he asserted:

> I felt like Neo [reference to movie entitled *The Matrix*] when they plug him in, and he gets out, and he's like, "I know Kung Fu." It was like I want more. That's what it felt like with me at [algebra PD] is like I know what I'm doing now. I get home, and I tell my wife like, "Yeah, that's the algebraic part. What I should be looking for is this. I should be looking for and what I should be asking is this way, not the way that I've been asking it. It just really sparked me, man. I wasn't plateauing, but I had no direction... Then with all of this [lesson study], I felt like I had a direction and it was like let's go. Let's go. These guys are supporting me. I feel like everything that we're doing is supporting.

This quote demonstrated an increase in epistemic learning leading to the acquisition of new knowledge, thus promoting goal attainment and feelings of achievement. Gino's confidence had increased because he was learning best-practice mathematical pedagogy. Before his lesson study experience, he did not know what to do and lacked confidence and pedagogical understanding. Moreover, Elena reaffirmed:

> Since I did alternative certification, I felt like I didn't have all the tools that a teacher that had gone through the normal four-year college process would have gained, and so I just

wanted more ideas on a way to reach the students, activities. I'm looking for a little bit of everything.

In addition to seeking pedagogical clarity, teachers also found comfort in understanding the *why* behind strategies. This supported the concept of pedagogical affirmation, as teachers desired to not only understand the pedagogical *what* but they also sought the pedagogical *how*. Blake explained:

> Whenever the group of myself and my peers were building the lessons, they basically consulted on the lessons and the strategies themselves. Specifically, for the strategies, kind of what ... You know, what is the purpose of this strategy? What does this highlight within mathematical structures of the different concepts? How are you actually making those concepts visible for the students? And so, a lot of times, it would just be reframing the question to uncover more about the strategy; why we're employing it, and once you kind of see the motivation, you can determine how best to use that strategy.

When Blake mentioned consultation, he was referring to the mathematics experts who helped the teachers understand the philosophy or goal behind certain pedagogies or strategies. This understanding helped Blake recognize the purpose or intentionality behind an approach and aided his ability to reproduce the goal using his knowledge and the knowledge of others. Having this deeper understanding of *how* helped the teachers make their own instructional decisions during the lesson study process.

Competence Theme II: Apprehension (Semi-Structured Interviews)

While the theme of emerging proficiency described the teachers' feelings of increased competence, the process inherent in lesson study also diminished these feelings. The second theme articulating competence included apprehension, defined as feelings leading to reductions in confidence or success while enacting a portion of the lesson study cycle. The subthemes of lack of communication and vulnerability supported the theme of apprehension.

- Lack of communication referred to feelings of angst in the group's ability to perform or achieve a collective goal due to problematic information exchange. Because every step of the

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lesson study process relied on the collective decisions and cooperation of all members, developing a lesson, preparing materials, and organizing lesson delivery according to a schedule also involved all members. In other words, all members had to be ready, on time, and support a common goal for the process to function as designed. This orchestration relied on precise communication, so disruptions or misunderstandings caused uneasiness with members when they felt underprepared to deliver a live lesson. These feelings caused a reduction in confidence. For example, Deanne observed, "[during the] second year, we were all massively dispersed from all different areas, so we had to be a little bit more creative on our planning and our time and how to get in touch with each other." The need to develop creative planning engendered feelings of apprehension due to the geographic challenges. Elena supported Deanne's claim when she emphasized, "I know with the group that I had we were spread out so it was sometimes hard to get together unless we were meeting with [algebra PD]. On our own time it was hard to talk about stuff." Similarly, Gino observed:

> I mean, sometimes there were people that were impossible to schedule things with. Sometimes that was like, I don't know if this lesson is going to be the best because we didn't really get to go over it as much as the last time that we did this. It's like, Well, okay. So-and-so did this. She didn't come to the last meeting. We can't see her. She's all the way in [removed specific location]. It was just a struggle a little bit.

This quote demonstrated the apprehension felt by participants when a lack of communication, caused by geographic distance or failure to return calls/emails in a timely manner, impeded the group's overall ability to properly plan and organize a live lesson.

- Vulnerability described the second subtheme and expressed the feeling that others would perceive one's teaching as inadequate, thus leading to a loss of dignity and self-respect. This sense of insecurity heightened due to using an unfamiliar pedagogy. Teachers assuming the

teaching role of the live lesson expressed feelings of anxiety because they did not want to look

bad in front of their peers. Marie acknowledged this vulnerability:

> [Teaching a live lesson compared to teaching students is] totally different, because they're also teachers. I was only teaching at the time maybe three years, and with all the bad experiences I've had, all the bad results I've had, I mean seriously I had one pre-AP class where no one passed. Yes, it was that bad. I had no passes, and I was so down. And to be observed teaching by all of these other teachers that you know are so successful, I'm like, "Do I know what I'm doing?" That's scary. And also it's very uncomfortable because it's different. I'm used to that "I do, You do, We do" because that's what they trained me. That's totally different. Inquiry-based with the lesson studies angle, it's so different. It's a different way of thinking as a teacher, as well that I have never experienced it before and that's scary. Very uncomfortable.

Marie admitted teaching the live lesson in the presence of peers created anxiety and an

intimidating environment. Her fear centered on two factors: (a) the first focused on teaching an

inquiry-based lesson when she traditionally used the gradual release of responsibility model (i.e.,

I do, We do, You do) and (b) she felt others would judge her based on being a less-effective

teacher. Chloe endorsed Marie's position when she stated:

> . . . you see somebody do it [teach a live lesson] and you are like, "Man, they did a really good job," and then you're like, "Now I have to do it and everybody is going to watch me do it." When you see somebody else do it and then you're like, "I hope I can do as good as that," then it kind of makes you more nervous. I mean I didn't really want to teach in front of everybody, but I still wanted to do it you know?

As a relatively new teacher, Chloe experienced a loss of confidence because she questioned her

ability to teach as well as the previous teacher. She became insecure when comparing herself to

the other teachers since she perceived them as more experienced. Both Chloe and Marie were

relatively new and inexperienced teachers, which added to their feelings of vulnerability.

However, Sharon, a teacher with over 20 years of experience, similarly felt nervous assuming the

teacher role during a live lesson. She reported:

> Well both years they came to my room, my class and also, you know it was other's people's too. But they came and you know somebody comes into your world and you're

trying to see how to improve and you feel very vulnerable and exposed. But anyway, it makes you nervous, everybody was nervous, not just me. But it was really good though.

Although Sharon had been a teacher for over 20 years, she also experienced feeling vulnerable. She described her nervousness as a normal reaction to feeling observed or as she later explained, "It just always makes you nervous when somebody comes in your room."

Although these teachers experienced feeling vulnerable during their live lesson when they assumed the teacher role, they described their feelings as temporary and ultimately felt the overall learning experience far outweighed the negative aspect of feeling vulnerable. Though Marie expressed feeling nervous and anxious she concluded, "It's like learning how to drive or ride a bicycle. It's uncomfortable at first, but you just get used to it." Moreover, Sharon asserted:

> Well just in the beginning you know, I was scared but I think it builds your confidence and it's just that amazing to work with people and see your ideas and there were some really gifted people in that class. I felt like there were great examples and in the end I also felt like they were humble and they were very helpful.

Although teachers may experience vulnerability at the beginning of the lesson study process when assuming the teacher role during the live lesson, the feelings were temporary. The teachers expressing this concern revealed losing confidence; however, those feelings were short-term. After experiencing the support of their peers and realizing they were not being judged, they enjoyed the long-term learning effects that far outweighed the temporary feelings of discomfort.

The theme of apprehension described how teachers temporarily lost competence during the lesson study process. A lack of communication and feelings of vulnerability produced reactions leading to reduced confidence and success. For example, teachers lost the feeling of preparedness when the group failed to properly plan for a live lesson. This difficulty was mostly due to geographic separation and reflected the most serious cause of frustration. Additionally, feeling vulnerable when assuming the teaching role during the live teach created anxiety.

Although this feeling occurred with both new and experienced teachers, they admitted the feelings were normal and temporary. Once they practiced the lesson study process and realized they were in a safe space designed to help them improve as part of a learning process, their feelings of vulnerability subsided.

In conclusion, the semi-structured interviews described how teachers experienced both increases and decreases in competence. The theme of emerging proficiency described how teachers perceived lesson study's ability to increase perceived feelings of confidence and success. These positive feelings increased when teachers received collective validation from their peers and when they witnessed the successful implementation of new pedagogy via pedagogical substantiation. Additionally, receiving acute feedback from mathematics-focused peers during the revising step provided much appreciated support in improving lesson quality leading to improved student outcomes. Lastly, the teachers gained confidence when lesson study satisfied their desire to learn and understand effective mathematics-specific pedagogy via pedagogical affirmation. Taken together, these subthemes support the teachers' perceptions of gaining mastery and effectance of a goal representing personally meaningful achievement. However, not all aspects of the lesson study process led to feelings of competence (see Table 20).

Table 20

Frequency Table for Competence Subthemes

Theme	Emerging Proficiency				Apprehension	
Subtheme	Collective Validation	Pedagogical Substantiation	Acute Feedback	Pedagogical Affirmation	Lack of Communication	Vulnerability
Marie	0	3	3	1	0	2
Blake	1	1	2	4	0	0
Chloe	1	1	0	0	0	1
Kamace	1	1	3	2	0	0
Sharon	0	1	4	0	0	3

Theme	Emerging Proficiency				Apprehension	
Subtheme	Collective Validation	Pedagogical Substantiation	Acute Feedback	Pedagogical Affirmation	Lack of Communication	Vulnerability
Elena	2	4	7	1	1	1
Gino	2	0	5	8	1	0
Deanne	0	1	2	1	1	0
Total	7	12	26	17	3	7

Note. Values reflect the number of times a participant referred to a subtheme in semi-structured interviews; a zero indicates a participate did not refer to that subtheme.

Research Question 1–Subquestion 2: How do teachers experience relatedness when participating in LSOA?

The second subquestion informing RQ1 (i.e., How do teachers perceive the motivational contextual factors offered by lesson study with open approach?) incorporated relatedness. Relatedness addresses connectedness from a social perspective. This connectedness included being part of a safe and supportive social group comprised of individuals whom one respects or values. Additionally, connectedness included feeling satisfied that one provides meaningful contributions to the group and considers themselves an important member of the group. (Ryan & Deci, 2017).

The results of the semi-structured interviews incorporating relatedness included three themes and seven subthemes (see Table 21).

Table 21

Relatedness Themes and Subthemes from Semi-Structured Interviews

Theme	Subtheme Informing Theme
III. Synergy – collaboration creating ideas greater than individual contributions	Meaning Negotiation – working with others to understand how to operationalize new pedagogy Collective Solidarity – learning curve less daunting when all are experiencing similar challenges
IV. Minor Barriers – minimal obstructions temporarily	Collective Rejection – emotional distress when group devalues an idea

Theme	Subtheme Informing Theme
impeding task completion	Time Consuming –implementing lesson study with fidelity requires time commitment Overwhelming – too many suggestions from group make it difficult to narrow focus
V. Interpersonal Dynamics – interaction quality among members when performing collaborative functions	Positive Interpersonal Dynamics – harmonious interactions characterized by a feeling of connectedness Contentious Interpersonal Dynamics – inharmonious interactions characterized by diminished feelings of connectedness

Note. Information in table represents results from interviews; it does not include information from written reflections.

Relatedness Theme III: Synergy (Semi-Structured Interviews)

Synergy represented the first theme and illustrated how collaboration facilitated ideas, resources, lessons, and revisions greater than individual ideas. To illustrate, the participants mentioned they became aware of new ideas and negotiated meaning with one another, which eventually led to the development of ideas, lessons, and plans that produced superior results compared to the simple combination of individual suggestions. Meaning negotiation and collective solidarity combined to support the theme of synergy.

- Meaning negotiation articulated the ability and space to work with others to explore new ideas by (a) questioning thinking, (b) listening to the interpretations of others, (c) discussing ideas, and (d) having the time to process information; thus leading to a deeper analysis of pedagogical understanding and clarification. This included an appreciation of exposure to new ideas and ways of thinking. To illustrate, Blake acknowledged:

> I think it's very valuable, because you . . . A lot of times, our classrooms are kind of our own island, so being able to collaborate with peers that experience the same things that you do across the board teaching, it just gives more perspective and more ideas, and more depth to the ideas that anyone comes up with.

Blake's quote suggested collaboration produced superior ideas incorporating greater depth when compared to ideas developed in isolation. Moreover, Chloe advocated, "[suggestions from

others] makes us better teachers, I think it makes better lessons because two heads are better than one." Gino supported Chloe's experience by stating:

> Yeah, the other people in the group. It was like, "What would you do if this happens?" Like, "Oh, I hadn't thought about that. Yeah, you're right. I need to change it up for that." It was easy that way. It was good that way. I liked it.

Gino appreciated receiving critical feedback in a safe space related to anticipating student responses to instruction not initially considered. He found this information valuable in developing an effective lesson. Additionally, Gino added:

> Sometimes during lunch, I'd find myself going over to those people that had good ideas during the class. I'm going to go have lunch with them, pick their brain a little bit. It just felt like I was picking everybody's brain.

This quote reinforced the value of negotiated meaning and learning through the perspectives of others. Deanne supported Gino's view by imploring, "When we talked about [lessons] . . . it just broadened the teacher-lesson creating perspective." Moreover, Sharon emphasized, "The people in my group helped me so much and occasionally I really helped them, but they really helped me a lot. If it hadn't of been collaborative like that, then we might not have learned as much." Elena extended Sharon's position when considering:

> I like getting in with a group and feeding off of each other. Because I get the ideas when I'm talking to other people to bounce around ideas. Because sometimes I don't think of things that maybe somebody else comes up with, so I really like being collaborative. And then I can take it, process it for a while, and then figure out how I would use it or maybe how I would tweak what I do . . . .

Sharon reminds us that the collaborative nature of lesson study provides space to brainstorm and create ideas from others. Lastly, Marie summarized the subtheme of meaning negotiation by reasoning:

> I like that part of the lesson cycle, because I don't think one person can have all of it. There's huge value in collaboration because everyone thinks differently. Everyone has different points of view, and everybody knows something a little extra that the others don't.

Marie reinforced how teachers appreciated the ability and space to become aware of new ideas

gained from the experiences of others. This varied experience led to many discussions promoting

the brainstorming process and creativity in lesson design.

- Collective solidarity, the second subtheme of synergy, referred to experiencing new

learning in the presence of other teachers. The challenges associated with growing pains, often

connected with new learning, declined when everyone in the group experienced similar

challenges. For instance, Blake insisted, "having peers that are experiencing the same thing lends

itself to gaining confidence." Kamace reinforced Blake's explanation of collective solidarity

when she responded, "there were other people involved in it [process of lesson study] and it

wasn't just my decision by myself. Then even when we taught it and changed things, it was still a

group effort." These statements allude to increased feelings of confidence when implementing

and experimenting with new pedagogies due to feeling part of a safe and supportive

environment. The feelings of safety, associated with the environment, increased because all

members embodied the position of learner (i.e., equally inexperienced). Additionally, Marie

included:

> [Working with others was] a huge factor, because if I tried [teaching a new pedagogy] by
> myself, I'd feel very odd, I think. And I don't think I'll have the confidence to do all the
> pieces and parts that's required for the lesson study. And I think I just go, "Oh, I get it.
> Let's just do this part only." But by doing it with others, we're forced to actually do every
> single step and every single piece of the study. It was a much comprehensive . . . It's
> more comprehensive and it's a better experience.

According to Marie, the concept of collective solidarity not only increased her confidence, it

increased her willingness to include every part of the new pedagogy. In a sense, working

collaboratively introduced peer pressure to implement the pedagogy from a comprehensive

standpoint. Without this pressure, Marie suggested she would not have had the confidence to try

all portions of the new pedagogy, thus suggesting collective solidarity had the power to help

push individuals out of their comfort zone because of the support, encouragement, and expectations of the group. Ultimately, Marie completed every step, thus making her learning experience comprehensive and ultimately promoting enhanced learning.

Relatedness Theme IV: Minor Barriers (Semi-Structured Interviews)

Minor barriers conveyed the second theme associated with relatedness. The barriers were, ultimately, minimal obstructions temporarily impeding the progress of task completion related to the lesson study experience. These barriers represented negative aspects or difficult situations associated with collaboration. Collective rejection, time commitment, and feeling overwhelmed encompassed the minor barriers theme.

- Collective rejection included emotional distress, often described as hurt feelings, resulting from the group's rejection of or devaluing of a member's idea or suggestion by not incorporating them into the group's lesson. Deanne asserted, "[In my] second group it was a lot more touchy-feely, people got their feelings hurt." In similar fashion, Gino affirmed:

> I think it's just that it's hard when you're growing. I mean, there's growing pains, man. You take things personal when the group consensus is this person's project or activity not yours that you thought was amazing. I mean, some people could take it the wrong way and some people were like, "Okay, yeah. That's a little bit. Maybe I can up mine and do this." That's how I felt it . . . was when mine wasn't being picked. I was like, okay. What can I do on this one so next time it is picked?

Gino experienced collective rejection when the group did not endorse or incorporate his lesson idea. He took this rejection personally; however, he demonstrated grit when he ultimately chose to increase the quality of his suggestions to reduce the probability of future rejection. Gino's further statement, "What can I do so they do pick it? That's how I took it. It was just I don't know. I felt everything, I just had a good attitude about it" personified his level of commitment to improve and overcome feelings of collective rejection. Moreover, Gino extended the concept of collective rejection by acknowledging:

At the time when I started [algebra PD], I'd already been teaching like six years. You're kind of set in your ways a little bit. That's why I'm saying, I can see people taking it the wrong way. I can see people not taking it as advice and taking it as a stab at you like, "Well, this works at my school." Kind of a thing.

This assertion suggested collective rejection could have a greater influence for experienced teachers who had established epistemologies and teaching practices. Experienced teachers, according to Gino, could experience increased feelings of collective rejection if the group rejected their more experienced ideas. These experience teachers could take advice or suggestions as personal criticism.

- Time consuming described the second subtheme supporting the theme of minor barriers. This subtheme communicated the time commitment necessary to complete the lesson study cycle with fidelity. Assembling teachers, collectively developing a lesson, teaching a live lesson, and making revisions with multiple iterations took a great deal of time. Marie supported this theme by observing, "To do it, because it's very time-consuming, to be honest. And doing one, it took us a long time to just do one." Kamace added, "I did find it to be a little time . . . Well, it took a lot of time. I thought it was worth it. It just keeps you from doing it more often because it takes up so much time." Although implementing lesson study required a significant amount of time, the teachers reported the learning justified the time commitment.

- Feeling overwhelmed is the last subtheme and completes the theme of minor barriers. Feeling overwhelmed referred to the problem of receiving too many suggestions during the collaborative lesson-planning session. This situation occurred when group members produced such a high number of ideas, they felt frustration due to an inability to streamline and focus. Chloe described, "Because some people don't really want to take no for an answer" as one of the reasons for the group accepting a large number of suggestions. She continued by suggesting:

> A lot of times if I had to get up there and teach I didn't feel as successful, because sometimes . . . I mean it ends up being a great lesson, but it also ends up being four people trying to make the best lesson ever, which sometimes just makes a really big lesson and you don't have all the time in the world, it's kind of scrunched.

The process of developing a lesson with an overwhelming number of activities did not fit into the scheduled class time. Chloe rushed her teaching to accommodate the large lesson and ultimately felt less successful as a result. Later in the interview, she reported using the same lesson in her classroom after the lesson study process ended; however, she took two days to deliver the lesson. She reported the extension allowed for a better teaching experience. By the same token, Elena acknowledged:

> I think, with Group 2, because we were talking about a lot of different ideas, it got a little overwhelming, and so sometimes there was too much choice, if that makes sense, and so it got a little overwhelming on what to choose. And, like I said, when I get that, I have to shut down and back off a little bit to figure out what it is that I'm thinking and what I want to do. I guess it motivates me more to figure out what's the goal of the lesson, what am I trying to get across to the students, what is the goal for the day?

Although Elena felt overwhelmed, she forced herself to focus on the lesson goal to narrow the scope of information. Her group eventually narrowed the focus, but Elena described a period of experiencing mild stress as a result.

Relatedness Theme V: Interpersonal Dynamic (Semi-Structured Interviews)

Interpersonal dynamics denoted the third theme associated with relatedness. This theme described how participants interacted with each other when performing collaborative functions. Interpersonal dynamics included quality of communication and equality of work distribution, as well as (a) respect, (b) trust, (c) common goals, (d) open mindedness, and (e) togetherness. The subthemes of both positive and contentious interpersonal dynamics embodied the theme of interpersonal dynamics.

When reviewing findings associated with interpersonal dynamics, readers must recall during the first year of the algebra PD, researchers assigned participants to groups based on similar geographic location (i.e., lived/worked near one another). However, during the second year, researchers reassigned participants according to the Team Creation Framework (Petty et al., 2018). Therefore, the team reassignments explained why some participants reported both positive and negative interpersonal dynamics.

- Positive interpersonal dynamics expressed harmonious interactions among members, including positive and effective communication bolstered by respect, trust, and open mindedness. Additionally, this subtheme included demonstrating a sense of togetherness and equal distribution of the workload related to duties associated with the lesson study process. Gino articulated positive interpersonal dynamics as, "[my] first group, I felt our dynamic was amazing. It was just crazy. I couldn't believe that I did not know these people and now we're making pretty legitimate lessons. It was just crazy." In like manner, when discussing her first group, Kamace reported, "We all got along, and I don't remember having a single bad experience with those people." Similarly, Blake believed:

> The way that my groups interacted with each other was very open-minded. Everyone was positive and willing to try things, even if they hadn't tried it before. Everyone was very open to discussion and feedback, especially if it was constructed around an idea or a strategy, or something that wanted to be incorporated into the lesson. Everything was just very open and positively collaborative . . . It seemed like everyone was working toward a common goal and wanted to see it be successful.

Blake reinforced many of the elements associated with positive group dynamics, including a willingness to entertain new ideas, receiving feedback in a constructive manner, and working toward a common goal. Blake added:

> I would say that [the positive group dynamics] increased my learning and everything that I did learn, there was a greater depth. As far as learning, because we actually got to

explore it and spend time talking about it, and when everyone is open to trying new things, you can take those positive risks which leads to learning.

This quote endorsed Blake's belief that positive group dynamics increased his ability to learn because he felt supported to take learning risks when everyone was open to new approaches. Open and effective communication allowed the members to take the time to thoroughly explore ideas leading to deeper learning. Both Blake and Gino reflected on the sense of togetherness felt in their groups. Furthermore, Deanne expressed:

> My Year 1 group, the three of us had already worked together a year, so by the time we were doing the lesson study we were in our second year of working together. We already collaborated, every lesson that we did in our classrooms was planned out together, the difference was in how we delivered it and our personalities. We were pretty on-par with our topics, so we were really close knit. Then we added [another member], and he's just a 100% go-getter. I mean, there was no slowing the kid down. If any one of us got behind, he would help pick up the slack. We were a pretty tight group. We were able to be a lot more open and honest, we weren't afraid of if I'm gonna hurt his feelings or what not. It was kind of point-blank. Also, us knowing our colleagues, the three of us knowing each other, we kind of already knew things. This is your strength, this is my strength, so you'll do this part of the lesson study, I'll do this part of the lesson study. We had the discussion on who should teach in whose classes, and we're like, but you know [student name] and [student name] are in this class, so maybe you should teach it because they don't usually listen to me so it's not gonna be effective. That background knowledge made it much easier to set up a successful lesson study.

Deanne described feeling part of a safe and caring environment in which all members had a common goal and equally contributed to meeting their goals. She reported her group as close knit and supportive; as a result, if someone needed help, the group members aided others when necessary. There was a high level of trust and everyone knew that ideas, suggestions, and criticisms were not personal and no one took feedback personally. Due to the positive interpersonal dynamics, Deanne believed her ability to learn from lesson study increased.

Sharon similarly credited positive interpersonal dynamics as a major reason for her increased learning but cited different reasons. After Sharon portrayed her group as "very helpful and very supportive," she maintained:

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> Well first of all, when you have to come on Saturday mornings it makes you more willing to go, because you're tired, you know it's going to be worth it once you get there. When you like the people you're working with, like at my job now, I really like the people I'm working with and that just makes all the difference and I go out of my way to be the person that they wanna work with, and I think they do the same for me and it just makes work so much better when you can be in group like that. That was kind of how it was. You're motivated to go because you know you're going to get a lot out of it and enjoy the day with the people you're with.

Sharon reported positive interpersonal dynamics increased her learning because she wanted to please and support the colleagues she cared about and who she knew cared for her. She did not want to disappoint others or not live up to their expectations based on her perceptions. In the same way, Gino accentuated:

> They put in all their work. It's like, okay, I really need to do my part. I felt like it motivated me because I was so on to try to do my part that I was doing more, and trying to help more, and stuff. I felt they were helping me, so I try to return the favor.

Sharon and Gino reported positive interpersonal dynamics increased their incentive to participate and contribute in a meaningful manner. They did not want to disappoint their colleagues and promoted affirmative reciprocity.

- The subtheme of contentious interpersonal dynamics completed the theme of interpersonal dynamics. Contentious interpersonal dynamics included exchanges among group members characterized by inharmonious interactions, thus diminishing feelings of connectedness and equitable fairness. Of the teachers interviewed, four of the teachers who participated in lesson study groups self-reported as contentious. However, they reported dissimilar reactions when describing how contentious interpersonal dynamics influenced their ability to learn from lesson study. For example, both Kamace and Deanne reported working in groups characterized by contentious interactions. Kamace stated:

> But we just had somebody that we knew was going to be hard to get along with, had to have her own way. We already knew that because she was in lesson study the first year. But somebody that was new that second year turned out to be a mini younger version of

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the same person. So, putting them in the same group... we'd just sit back like, 'I don't even care about the resolution of this argument,' and we'd just let them argue. So, it took up valuable time. It was just like, 'This isn't like last year. It's about things that, man, it's not that important. Who's going to teach the lesson? This little nitpicky thing, we got to do this. It turned out that we're just watching the two of them fight and the rest of us are just sitting there. Then [another group member] always the peacemaker and he's trying to break it up or get them to see reason. It really didn't help. I don't know. Then we had, I think, more people than most groups too. I think we had five. So, that, more people you add, then the more people you have to get to come together to a consensus.

Kamace articulated her frustration due to the contentious interactions between two members of her group. The arguing between members centered on an inability to compromise or appreciate the ideas of others. Additionally, Kamace's irritation increased when, according to her perception, the topic of the disagreements reflected trivial issues. Despite another member's attempts to diplomatically resolve the quarreling, the contentious interactions continued throughout the entire duration of the lesson study. When addressing how the contentious nature of the interpersonal dynamics affected her learning, Kamace replied:

Well, I don't think we learned as much as we could have because we spent too much time arguing about stuff that didn't even matter. So, didn't feel like I got as much. I don't think I got anything more out of it that year, which I should have because it's my second year in it, than I did the first year.

While Kamace did not report a loss of learning due to the dynamics, she suggested her learning did not reach its full potential. Essentially, she maintained the same level of learning during her first year of participation.

Despite the negative dynamics Kamace experienced she still offered ideas, "I was comfortable doing that. You just never knew how it was going to go after the idea was put out there . . . you just have to not have a thin skin when you know you're dealing with people that just like to argue . . . ." Therefore, Kamace willingly offered ideas even though they were subjected to negative feedback. Moreover, she admitted after offering ideas, "[they] just got drowned out in arguing about minutia." Although, Kamace reported high levels of frustration

with her contentious group members she maintained her enthusiasm to participate in lesson study. She admitted, "Okay. So, I wasn't allowed to choose the first year, and I was highly motivated. Didn't have choice the second year. I was still motivated." In the end, Kamace experienced frustration with two group members, but she maintained her persistence to continue learning.

Like Kamace, Deanne experienced similar frustrations in a group with two contentious members. Deanne reported:

> [My second group] was way more diverse than my first group, and because of that there was a whole lot more headbutting that went on. Things got resolved, so we never had any . . . there was never any massive issues. But there was constant conflict. We don't agree on this, we don't agree on this, we don't agree on that. Conflict results from consistent disagreement. I'll take care of this, you didn't take care of it, so now who's gonna take care of it? Who's gonna pick up the slack when you don't get your job done? Or you showed up late, you didn't bring what you said you were gonna bring. It was one of those situations. Our headbutting came across, I don't know if it was intended that way, but it came across more of I know better than you so we're gonna do it my way. The headbutting was the rest of us saying no we're not. And not as much of, I see us doing it this way, and you see us doing it this way, so how are we gonna figure out how to teach this when we all come from different perspectives? We didn't have that direct differences of perspective. It was, I know what I'm doing and this is the way we're gonna do it. And we're like, no we're not. Our headbutting was I guess different then.

Although the conflicts were described as never massive and eventually resolved, Deanne did feel a consistent underlying stress due to the persistent disagreements. The stress increased when members lacked follow-through with assignments. Additionally, the disagreements did not fundamentally center on philosophical differences but manifested as a lack of flexibility or inability to compromise. In order to meet the deadline of completing the lesson, the group used majority rules to make decisions. Deanne reported:

> Yeah, we ended up doing the same . . . not exactly the same, but very similar. I mean, we took the lesson that my group did the first year . . . . Having more minds from different schools and different perspectives allowed us to make massive edits to this assignment and turn it into a one-day type thing and narrow down our focus, but by being able to do

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that same lesson study a second year, we saw way more improvement than we did the first year.

Despite expressing a high degree of frustration due to the contentious nature of two teammates, Deanne reported the group eventually improved the previous year's lesson. When asked directly if Deanne received value from her second-year lesson study experience, she reported in the affirmative. However, she did add, "Well, we weren't able to get down to the lesson study as deeply as we wanted." Deanne also reported her initial reaction to the conflict as:

> I didn't know the people, and there was already conflict, and I was just like, oh crap I'm just gonna keep my mouth shut. That's kind of the perspective I took until we got into the lesson, and then we were in an area that I was comfortable with because I had already done the lesson before and they hadn't. Then the tables turned a little bit because then I became the expert of the lesson itself, having done it once before, and they hadn't.

This suggested Deanne felt uncomfortable because of the conflict and initially withdrew from making comments or suggesting ideas. However, as her confidence increased she eventually engaged in the disagreements, or in Deanne's case, assume a leadership role.

As previously mentioned, four teachers reported contentious groups. While Kamace and Deanne suggested the conflict discouraged the full potential of their learning, Gino and Marie articulated the opposite effect. Gino described his contentious group experience as follows:

> . . . so everyone has their idea of how something should be taught or what lesson should be used, the perfect lesson, and, "Well, I like it this way and I like this way. Review games should look like this." There's times where people butt heads, but I felt everybody had their little spat. The next time we come around, everything was good again.

Gino described contentious relationships between members; however, based on his description, the group returned to a manageable agreement equilibrium after disagreements. Gino described his learning based on this dynamic as:

> Then I was bummed out because a couple of them didn't return. Then they tried to spread us around a little bit with newbies that came in for the second year. It wasn't as family feeling, but we did some great work. I think we did greater work than the previous year's group. I just think it was a little more effective, I guess, and just less family feel

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whatever. But I mean, that's what I felt like the first one was definitely like a family feel. Yeah. I don't text them as often [referring to the second group]. I mean, I don't think I've texted them or the others that I text are like, "Check out this meme." Or, "Check out this." Or, "Hey, I saw this is playing at movies. Remember you said you liked that movie." Just things like that.

Gino deliberately described the closeness of his first group as family-like and reflected fondly on the depth of their relationship. However, he insisted that, although his second group did not feel like a family, they experienced a greater level of learning.

Like Gino, Marie participated in a group characterized by contentious interpersonal dynamics during her first year. When reflecting on her first group experience, Marie admitted "we were not a very well-functioning team." She continued by stating:

I learned a lot more in that one [contentious group] because you have to justify. I have to justify what I'm doing. Whereas the second time, everything went so smooth, we were done before I knew it. And I'm like, "Okay, I didn't really learn much because we're experiencing it again and comparing the experience." So yeah, I learned more when we had that clash. Even though it was very negative.

Marie revealed an important dynamic generated from a contentious relationship among members. She learned more from this group because everyone had to justify and defend their ideas, which led to deeper learning and understanding. Marie's second group was so easy-going, they simply agreed with all ideas and avoided justifying or challenging each other's ideas. According to Marie, "We didn't really get much feedback from each other," which led to diminished learning. Furthermore, Marie recounted her learning experience based on her contentious group as:

They didn't do a lot of the work because of [arguing], so it left it to the two of us, instead of the four of us. They did their share, but not as much as certain things because they're off arguing too much and starting to decide why they're right, right? So I learned more because we have to take on a higher load. But at the same time, since I have to actually do a lot of the parts instead of just my one section, I saw it more. So yeah. Interestingly. There's some value in tension. In rough teammates.

Marie's increased learning, resulting from contentious interpersonal dynamics, included assuming extra responsibilities. This reflected an unequal workload, but Marie learned more as a result of completing work neglected by others.

In summary, teachers generally enjoyed and valued the collaborative nature of the lesson study process. Working with others increased their exposure to new ideas and created a safe space to negotiate meaning when interpreting new pedagogy. This allowed the participants to create ideas greater than the sum of their individual ideas. Moreover, learning with a group placed all individuals in similar status, because they all assumed the position of learner. This made growing pains less daunting as everyone experienced similar challenges. This collective solidarity provided reassuring peer pressure, which supported the full and comprehensive implementation of newly learned pedagogy.

Although working with others offered a supportive learning environment, the constant presence of collaboration elicited marginal hindrances temporarily impeding progress. These impediments included (a) hurt feelings, (b) finding the time to commit to the lesson study process, and (c) feeling overwhelmed at times. Though irritating, these roadblocks demonstrated temporary issues that slowed progress. The participants, in all cases, overcame these barriers and facilitated quality learning experiences.

Finally, interpersonal dynamics framed the collaborative process of lesson study in intriguing terms. While participants experienced both positive and contentious interpersonal dynamics, the learning results based on these dynamics varied. Subjects imbedded in positive groups credited harmonious interactions contributing to their ability to learn at high levels. However, the four subjects experiencing contentious dynamics articulated contrasting results. Two participants credited inharmonious interactions as contributing to increased learning, while

two reported a similar environment prevented their learning from reaching its full potential.

The second data source promoting triangulation for how teachers experienced relatedness included a content analysis of teacher written reflections. The reflection prompts used were: (a) Discuss how you get along with the other teachers in your lesson study group. How does this relationship help or hurt your learning? and (b) Describe the pros and cons of working with your lesson study group and explain how each ultimately affected what you do in the classroom. The participants responded to the first question at the beginning of their second year and answered the second question toward the end of their second year.

The content analysis revealed three main themes: (a) interpersonal dynamics, (b) synergy, and (c) minor barriers. Additionally, a total of nine subthemes emerged to form the three main themes (see Table 22).

Table 22

Relatedness Themes and Subthemes from Written Reflections

Theme	Subtheme Informing Theme
III. Synergy – collaboration creating ideas greater than individual contributions	Meaning Negotiation – working with others to understand how to operationalize new pedagogy Collective Solidarity – learning curve less daunting when all are experiencing similar challenges
IV. Minor Barriers – minimal obstructions temporarily impeding task completion	Overwhelming – too many suggestions from group make it difficult to narrow focus Limited Experience – participants wanted to experience more roles and live lessons
V. Interpersonal Dynamics – interaction quality among members when performing collaborative functions	Positive Interpersonal Dynamics – harmonious interactions characterized by a feeling of connectedness Meaningful Collaboration – positive interpersonal dynamics promote effective learning Conflict Apprehension – fear of conflict leading to less learning Contentious Interpersonal Dynamics – inharmonious interactions characterized by diminished feelings of connectedness

Note. Information in table represents results from written reflections; it does not include information from semi-structured interviews.

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Relatedness Theme V: Interpersonal Dynamics (Written Reflections)

The first theme emerging from the teachers' written reflections included interpersonal dynamics. This theme described how participants interacted with each other when performing collaborative functions. Interpersonal dynamics included quality of communication and equality of work distribution, as well as (a) respect, (b) trust, (c) common goals, (d) open mindedness, and (e) togetherness. The subthemes of (a) positive interpersonal dynamics, (b) meaningful collaboration, (c) conflict apprehension, and (d) contentious interpersonal dynamics embodied the theme of interpersonal dynamics. These findings, like the semi-structured interviews, are framed from the understanding that all participants participated in two different groups over the two years of the algebra PD. Therefore, some participants reported both positive and contentious interpersonal dynamics.

- Positive interpersonal dynamics expressed harmonious interactions among members, including positive and effective communication bolstered by (a) respect, (b) trust, and (c) open mindedness. Additionally, this subtheme included demonstrating a sense of togetherness and equal distribution of the workload related to duties associated with the lesson study process. To illustrate, Sharon reported, "My study group is easy, we get along and everyone brings something to the table. Everyone is open to helping others." Additionally, Marie reported, "My lesson study group this year is very cohesive and has no conflicts." These examples explain the harmonious interactions experienced by Sharon and Marie.

- In addition to positive interpersonal dynamics, the subtheme of meaningful collaboration contributed to the theme of interpersonal dynamics. Meaningful collaboration referred to feeling that harmonious group interactions enhanced one's ability to learn from lesson study. Blake supported the concept of meaningful collaboration by suggesting:

I get along quite well with the members, which allows for meaningful collaboration and sharing of ideas, and minimizes unresolved conflict between the members. In our larger grant group, there are only a few individuals, two, with whom collaborating would be difficult.

Blake credits a harmonious group dynamic as one of the reasons for his ability to learn and suggested conflict between members could diminish learning opportunities. In the same way, Sharon reported:

I was a little nervous when assigned groups because I wanted to have a group with people that I can get along with and collaborate well. I think this helps my learning because I am more open and can talk with people I get along with easier. I have seen with my students how they shut down when they are with somebody they don't know at all or have had a previous disagreement with. I think the same concepts would apply with adults.

Sharon reflected her belief that harmonious group interactions lead to better and more effective learning, while disharmonious dynamics (characterized by disagreement) would reduce one's capacity to take advantage of collaboration.

- The third subtheme supporting the main theme of interpersonal dynamics, conflict apprehension, represents a fear that conflict or disagreement within a group leads to less learning. Kamace contended:

I think I "get along" with everyone, even though there is definitely more tension in this year's group than there was in my last group. It remains to be seen whether this will be detrimental as we have only sat together for a few days this summer. I hope this will not hurt my learning—last year was phenomenal!

Kamace felt apprehensive about her group dynamics based on the fear that confrontational group members would create an environment detrimental to her learning. As revealed in the semi-structured interview, Kamace eventually reported a high level of disagreement between two members; she admitted the contention did not necessarily reduce her learning, yet it limited reaching the full potential.

- Contentious interpersonal dynamics encompassed the fourth subtheme supporting the

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main theme of interpersonal dynamics. This subtheme reflects inharmonious interactions, characterized by diminished feelings of connectedness. Deanne reported her experience of contentious interpersonal dynamics as:

> I also am not a person of conflict, so if I am grouped with drastically different personalities, I withdraw from being outgoing and just follow along. Last year I was with a group who thought a lot more like myself and so we were able to communicate our thoughts easier. I have learned from both groups, but got more personal growth from the first group.

This quote revealed Deanne's level of discomfort when working in a contentious group environment. She admitted to learning in both groups but preferred the personal growth fostered in a more harmonious group.

Relatedness Theme III: Synergy (Written Reflections)

The second main theme supporting relatedness included synergy, which illustrates collaboration leading to the creation of ideas greater than individual ideas. Meaning negotiation, limited experience, and collective solidary comprised the subthemes contained under the synergy theme.

- Meaning negotiation includes talking through ideas and processing different perspectives when interpreting understanding associated with new pedagogies or instructional strategies. Gino emphasized meaning negotiation when suggesting:

> Collaboration always inspires more creativity, there doesn't have to be just one leader in the group—because they know more or are more qualified, everyone had equal say—it taught us to be more open with each other and express our teaching philosophies through activities collaboratively. [Collaborating with others] pushed us out of our comfort zone—once I let go of worrying about being perfect and in control all the time, I was able to actually teach math concepts and not just specific TEKS [Texas Essential Knowledge and Skills].

Gino elaborated on the group's ability to inspire more creativity based on discussing teaching philosophies. Additionally, he mentions these discussions have the capacity to push individuals

out of their comfort zones and credits this collaboration effect with changing his teaching

paradigm to focus on conceptual teaching. Moreover, Elena reported, "The Lesson Study group

has given me new ways to present the same concept but differentiated levels to ensure that all

students are successful." This suggests the collaborative process of lesson study promotes

meaning negotiation, which leads to providing new presentation techniques.

The third and final subtheme supporting synergy was collective solidarity. This subtheme

reflects experiencing new learning in the presence of other teachers, which provides a level of

support as new learning pushes teachers out of their comfort zones. Gino claimed, "Going on this

journey with my lesson study group definitely provides a great support system and alleviates

some of the stress getting out of your comfort zone creates."

Relatedness Theme IV: Minor Barriers (Written Reflections)

The last theme associated with relatedness, minor barriers, refers to minimal obstructions

temporarily impeding task completion or causing slight frustrations. The subthemes of feeling

overwhelmed and having a limited experience inform the minor barriers theme.

- Feeling overwhelmed referred to participants who felt inundated with ideas, thus

making it difficult to narrow their focus. Elena stated:

> Although the pros definitely outweighed the cons of the lesson study group, the one area
> that sometimes was a struggle was the overwhelming amount of suggestions or getting
> bogged down with one aspect of a lesson and not able to complete other parts of the
> lesson with the same amount of time.

According to Elena, creating lessons in a collaborative environment encouraged the production

of too many ideas and suggestions. This overload created a deliberate need to focus on reduction,

which caused unequal attention to all portions of the lesson.

- Limited experience, the second subtheme supporting synergy, represented the teachers' desires to increase their experiences related to lesson study. This subtheme specifically addressed the participant's disappointment in not being able to experience all roles associated with the live lesson or experience more opportunities to apply lesson study in schools. As an illustration, Marie observed, "as a con maybe that I wasn't able to experience all the roles in a lesson study." This expression demonstrated the high value Marie placed on her learning experience. To suggest the con centered on not being able to participate in every role shows her dedication and appreciation for the learning provided by lesson study.

Additionally, Blake recounted, "The only cons to working with our lesson study groups were that we did not have more opportunities to participate together in lesson study and that some ideas were not applicable since we taught different content areas." By the same token, Gino conveyed:

> I didn't get to see more than two teachers teach (including myself), it would have been awesome to see everyone in my group teach. I wanted to specifically see a few teachers in our [algebra PD] program, but still enjoyed the teachers I did observe.

Both Blake and Gino reinforced their desire to extend their lesson study experience to witness more teachers and indicated the lack of opportunity as a con.

In summary, the themes and subthemes produced from the content analysis of the teachers' written reflections produced similar results when compared to the semi-structured interview results. Both sets of findings revealed that teachers experienced (a) positive and (b) contentious interpersonal dynamics, (c) meaning negotiation, (d) feeling overwhelmed, and (e) collective solidarity. However, (a) meaningful collaboration, (b) conflict apprehension, and (c) limited experience, findings from the written reflections, added clarity to the semi-structured results.

Table 23

Frequency Table for Relatedness Subthemes for Semi-Structured Interviews and Written Reflections

Theme	Interpersonal Dynamics				Synergy		Minor Barriers			
Subtheme	Positive Interpersonal Dynamics	Contentious Interpersonal Dynamics	Meaningful Collaboration	Conflict Apprehension	Meaning Negotiation	Collective Solidarity	Collective Rejection	Time Consuming	Limited Experience	Overwhelming
Marie	2	6	2	0	7	2	0	1	1	0
Blake	3	0	1	0	4	1	0	0	1	0
Chloe	2	0	2	1	3	0	0	0	0	2
Kamace	1	7	0	3	1	1	0	2	0	0
Sharon	9	0	2	0	4	0	0	0	0	0
Elena	1	3	3	0	6	0	0	0	0	2
Gino	4	2	0	0	4	3	2	0	2	0
Deanne	4	9	4	5	3	0	1	0	0	0
Total	26	27	14	9	32	7	3	3	4	4

Note. Values reflect the number of times a participant referred to a subtheme in both the semi-structured interviews and written reflections; a zero indicates a participant did not refer to a subtheme.

The subtheme of meaningful collaboration reinforced participant's belief that positive

interpersonal dynamics leads to effective learning. Moreover, at the beginning of the

collaborative experience, some teachers experienced conflict apprehension as a result of their

belief that contentious relationships would reduce their ability to learn from their collaborative

groups. Lastly, some participants reported a desire to increase the frequency of teaching live

lessons and having the opportunity to assume more roles and watch more individuals teach (see

Table 23)

Teamwork Quality Survey Results.

The third data source promoting triangulation related to teachers' experiences of

relatedness was paired sample *t*-test results. The first research question asked if collaborative

interaction quality increased after participating in LSOA for a year. Participation in a lesson

study group from September 2017 to January 2018 represented the single independent variable

and interaction quality represented the dependent variable (see Table 24).

Table 24

Results of Paired Sample t-Tests

| | n | Pre-Survey | | Post-Survey | | $t(7)$ | Sig. (2-tailed) | 95% Confidence Interval | | Cohen's d |
		M	SD	M	SD			Lower Limit	Upper Limit	
Interaction Quality	8	4.4	1.18	5.15	3.34	.01	1.30	.223	1.2	3.34

Note. Sig. = Significance.

Table 24 indicated a statistically significant increase of interaction quality scores from the

pre-survey ($M = 4.4$, $SD = 1.18$) to the post-survey ($M = 5.15$, SD .87), $t(7) = 3.34$, $p = .006$

(one-tailed). The mean difference in interaction quality scores increased with a 95% confidence

interval, ranging from 1.30 to .223. Moreover, Cohen's *d* (1.2) indicated a large effect size. As a result, I rejected the null hypothesis and accepted the research hypothesis suggesting participation in a one-year lesson study can increase collaborative interaction quality.

The interpretation of the TWQ survey findings suggested teachers participating in lesson study reported experiencing positive interactions while collaborating with peers. Additionally, the interaction quality among teachers increased as they progressed through the program. The total mean score for all facets increased from ($M = 4.40$) to a total mean score of ($M = 5.15$), which reflected an increase of .77. This total increase in score reflected a significant improvement, according to the *t*-test results and a large Cohen's *d* effect size of 1.2. Each facet in (a) communication, (b) coordination, (c) balance of member contributions, (d) mutual support, (e) effort, and (f) cohesion increased. Although the qualitative data exposed a certain level of conflict among some members, the survey data suggested conflict actually proved negligible in influencing overall interaction quality.

Communication

The communication facet supported the subtheme of positive interpersonal dynamics as teachers indicated they participated in a productive and effective process for exchanging information during collaborative. However, low pre-survey results indicated facilitating communication among members proved difficult at the beginning of the second year when researchers assigned new groups. This difficulty materialized as teachers procrastinated when responding to text messages or emails thus reducing communication capacity. This communication difficulty diminished as groups progressed throughout the year.

Coordination

The results of the coordination faucet suggested teams improved working in an

orchestrated manner over time. However, groups containing contentious members experienced disagreements throughout the entire duration of the program. Although conflict embodied some groups, the high means for questions 12 and 13 suggested they still achieved some level of task completion. This facet supported the subthemes of positive interpersonal dynamics, contentious group interactions, and ownership of activity/learning.

Balance of Member Contributions

Balance of member contributions supported the qualitative results, which stated conflict centered on a lack of flexibility due to an inability or reluctance to compromise. However, the overall results disclosed a high level of positive interpersonal dynamics.

Mutual support

Mutual support reminds us conflict existed in groups and according to the qualitative results, caused various levels of stress for some members. However, participants experiencing stress reported learning and ultimately accomplishing their task. The results of the questions in the mutual support facet supported the qualitative findings. Mutual support reinforced the subtheme of meaning negotiation and positive interpersonal dynamics.

Effort

The effort facet reported participants may increase their effort to contribute to the group's collective goals as they internalize the value of their learning.

Cohesion

The cohesion facet revealed a high level of appreciation to collaborative learning and learning from a group of peers. Additionally, the increase in importance and attachment of the project personified the internalization of value related to what and how teachers learned. This

facet supported the subthemes of positive interpersonal dynamics and value internalization.

In sum, the interpretation of the survey results produced or exposed patterns of information. The communication facet revealed positive interpersonal dynamics included open communication and equal control of information. A lack of communication surfaced due to an absence of direct and frequent communication, but this situation improved over time. The coordination facet inferred contentious relationships continued throughout the duration of the collaborative process while personal ownership of learning goals flourished over time. Mutual support promoted the teacher's ability and opportunity to negotiate meaning with one another and broaden understanding of pedagogy. The amount of effort to collectively achieve the group's goal increased over time. This exemplified how participants elevated their enthusiasm as they internalized the value of their learning. The last facet, cohesion, demonstrated positive interpersonal dynamics and the internalization of value (see Table 25).

Table 25

Frequency Table for Relatedness Subthemes Based on Teamwork Quality Survey

Subtheme	Positive Interpersonal Dynamics	Contentious Interpersonal Dynamics	Value Recognition	Meaning Negotiation	Lack of Communication	Ownership
Communication	1	0	0	0	1	0
Coordination	1	1	0	0	0	1
Member Contribution	1	0	0	0	0	0
Mutual Support	1	0	0	1	0	0
Effort	1	0	1	0	0	0
Cohesion	1	0	1	0	0	0
Total	6	1	2	1	1	1

Note. Values reflect the researcher's interpretation of survey results supporting a theme from each facet. A zero indicates survey information did not confirm a subtheme.

Research Question 1–Subquestion 3: How do teachers experience autonomy when participating in LSOA?

The third subquestion informing RQ1 (i.e., How do teachers perceive the motivational contextual factors offered by lesson study with open approach?) was about the topic of autonomy. Autonomy refers to a person's perceived understanding of feeling in control of one's decision to engage in an act or behavior. This feeling of control originates from one's free will to act not because of an external figure of authority (Ryan & Deci, 2017). The more a person perceives their actions deriving by or through their own volition, the higher the perceived autonomy. Conversely, autonomy declines when a person perceives their actions originating from an authoritative figure or externally mandated requirement. Moreover, autonomy includes acting on one's free will to engage in an act that aligns with a valued activity or authentic interest. The results of the semi-structured interviews, incorporating autonomy, consisted of one theme and three subthemes discussed below (see Table 26).

Table 26

Autonomy Themes and Subthemes from Semi-Structured Interviews

Theme	Subtheme Informing Theme
IV. Volition – making decisions based on one's choice or will	Growth Preference – ability of a participant to self-select their level of growth based on available choices
	Voluntary Participation – participating in lesson study based on choice and wanting to learn
	Ownership – having a choice when determining lessons, activities, roles, data collection methods etc. increased the worth and value of their learning thus making it more personally meaningful

Note. Information in table represents results from interviews; it does not include information from written reflections.

Autonomy Theme VI: Volition (Semi-Structured Interviews)

Volition was the single theme associated with autonomy and denoted a participant's ability to make decisions based on volition or one's free will. The subthemes of (a) growth preference, (b) voluntary participation, and (c) ownership characterized the theme of volition.

- Growth preference referred to the ability of a participant to self-select their level of growth based on available choices. Deanne emphasized growth preference when she reflected about roles:

> . . . most of us picked a role that we hadn't already done, so that we could experience more of the other roles instead of duplicating. We also got to, in that choice, talk about "well you've never done this before, this has a really good benefit." So we suggested to other group members what they should choose, because that helped them get more out of it. We'd already done it before and we're like, "this one's a good one for you to learn how to do this," when they were talking about their own weaknesses and that type of thing. For me personally, I like to pick stuff I've never done before and find out what it's like. I mean, if I'm gonna screw up on something, I'd rather do it where it's not an actual lesson in the classroom. This is done for practice and for learning sake, it makes it much easier to get out there and try something new, where if it messes up, it's not really hurting anything. That's kind of the biggest thing that choice gave for me.

Deanne articulated how choice allowed group members to assume various roles to experience new learning, and this choice helped participants enhance their learning experience. Additionally, this choice helped Deanne customize her learning experience to meet her specific needs according to her own judgement. Blake supported Deanne's claim by recounting, "It's very much the more that we put into it, the more we got out of it." This reaffirmed Deanne's thoughts that lesson study allowed the flexibility to choose the level of learning one preferred. Moreover, Gino added:

> Yeah. I mean, it's a choice on what activity you do. It's a choice on what assignment you want to take on. Everything is a choice like what do you want to excel at? What do you want to get better at? I felt I was choosing the stuff that I was weaker at so that I could get better. I mean, some people quite possibly got stuff that they were strong at. That's what they chose. Everybody's different. I mean, it's how much you wanted to grow. I wanted to grow a lot. I felt like it was a unique opportunity and I felt like I had to take advantage of it because it might not ever happen again.

Gino confirmed lesson study provided a large amount of choice in its design and enactment. However, this level of choice allowed individuals to work on improving weak areas, and this same kind of choice also allowed participants to promote areas in which they exhibited strengths.

Gino reaffirmed the level of growth lies with the individual. When reflecting on choice, Chloe realized:

> I think I liked having choice. I think sometimes trying to match up the timeline could get a little frustrating, because we could be like, "Oh that would be a really good topic to do, but he does it in August and we do it in March." Then that could get frustrating, but I think for the most part it, just made you feel more confident like you could do this, you could figure it out because you could do whatever was going to work for you as a group having the choice.

In addition to promoting customized learning opportunities based on one's self-determined needs, Chloe reminded us that choice, likewise, increased confidence when participants could choose their topics and lesson activities.

- Choice also included voluntary participation, which represented the second subtheme supporting the theme of volition. Voluntary participation prompted feelings of comfort because teachers chose to participate in the lesson study program, which subsequently reduced pressure. Blake strengthened this concept by expressing:

> I would say that it [intrinsic motivation] was high. I think everybody chose to participate in [algebra PD] on their own in general, and so choosing to participate in that and then seeing what was available, I think everybody was motivated to get something out of that.

Blake started the algebra PD program with enthusiasm and maintained motivation throughout the duration of the program. He reported having a high level of motivation to participate in lesson study because he chose to volunteer. However, his decision to return after the first year most likely occurred when the social and environmental factors associated with lesson study fostered and nurtured his initial motivation. Additionally, Sharon supported Blake's statement when she communicated:

> Because if people come to that first of all, you know, nobody's making them, so that's really good. Nobody made me do that, so "I'm here and I want to learn, and hear what you have to say and learn from you and maybe I have something I want to offer back." I really liked that.

Sharon found comfort in the idea that her fellow teachers chose to participate in the program to learn. In her mind, this suggested teachers wanted to help each other and work to complete tasks related to learning new instructional strategies.

- Ownership exemplified the final subtheme related to volition and explained that having choice when selecting lessons, activities, roles, and data collection methods increased the worth and value of participant's learning, thus making their activities personally meaningful. Chloe endorsed this concept when reporting:

> I think we had ownership because you came up with everything pretty much on your own. I mean we worked together, it was ours, you made it, we talked about it, we fixed it, we did everything together, so obviously there's ownership there because you made it.

Chloe appreciated having a high level of choice when participating in lesson study. This choice allowed her group to create everything about the lesson, as the group determined what to include and this, in turn, promoted increased feelings of ownership. Similarly, Blake added,

> "I think that opening it up for more choice . . . it is more motivating because . . . For me, because I feel like, 'Oh, okay. This is what I chose to do, so I definitely need to see it through."

Deanne likewise appreciated choice in lesson development when she urged, "We were working together as a group, so it felt more like a group ownership, not really like mine." According to these participants, the high level of choice associated with lesson study engenders feelings of ownership.

In summary, lesson study promoted volition by allowing and encouraging participants to self-select their level of growth in a program based on voluntary participation (see Table 27). Moreover, the myriad of choices associated with lesson study facilitated ownership, which increased alignment between the participants and personally meaningful learning activities. When examining the frequency chart, four out of eight teachers specifically mentioned feeling a

sense of ownership in their lessons. The concept of ownership developed naturally based on teachers responding to the question of how choice affects motivation. Based on my judgement, a clear majority of teachers would have responded in the affirmative to a question specifically asking if they felt ownership in a lesson they spent much time developing. Therefore, I included ownership as a subtheme.

Table 27

Frequency Table for Autonomy Subthemes

Theme		Volition	
Subtheme	Growth Preference	Voluntary Participation	Ownership
Marie	0	0	0
Blake	1	1	1
Chloe	1	0	1
Kamace	0	0	0
Sharon	0	1	1
Elena	0	0	0
Gino	1	3	0
Deanne	1	0	2
Total	4	5	5

Note. Values reflect the number of times a participant referred to a subtheme in the semi-structured interviews only; a zero indicates a participant did not refer to that subtheme.

Findings Related to Research Question 2

The second research question RQ2 (i.e., In what ways does lesson study with open approach connect with teacher motivation?) sought to understand how participation in lesson study might be associated with teacher motivation. Ryan and Deci (2017) claimed motivation exists on a continuum based on a person's perceived locus of causality. This causality refers to either an external source of authority or a person's free will. If a person believes their reason for engaging in an activity (motivation) comes from an external source, they will feel controlled.

Ryan and Deci refer to this feeling as *controlled motivation*. Conversely, if a person believes their reason for engaging in an activity originates from their own volition, they will not feel controlled. Ryan and Deci refer to this feeling as *autonomous motivation*, which increases the quality of performance and persistence when compared to controlled motivation. Furthermore, autonomous motivation increases when an individual maintains an authentic interest in completing a task. When an individual integrates and internalizes the value of a task, the more autonomously motivated they become because they choose to engage in the task due to their believe in its value, worth, and usefulness. To answer RQ2, I explored teacher perceptions related to internalization that increased or decreased feelings of autonomous motivation.

Autonomous Motivation Theme VII: Internalization (Semi-Structured Interviews)

Based on the thematic analysis of the semi-structured interviews, the theme of internalization described how lesson study helped teachers gain value in their own learning to the point of voluntarily implementing new classroom strategies based on their own volition. The subthemes of student response and epistemological shift supported the internalization theme (see Table 28).

Table 28

Autonomous Motivation Themes and Subthemes from Semi-Structured Interviews

Theme	Subtheme Informing Theme
VII. Internalization – process of acknowledging value and worth of behavior, thus leading to autonomous motivation	Student Response – teacher's willingness to implement new pedagogy based on favorable or unfavorable student response
	Epistemological Shift – teacher changes instructional paradigm

Note. Information in table represents results from semi-structured interviews; it does not include information from written reflections.

Student Response

The subtheme of student response included a teacher's willingness to implement new strategies in the classroom contingent on student reaction. This willingness included (a) observing both increases and decreases in student achievement, (b) enjoyment, (c) engagement, and (d) confidence. To illustrate, Gino reported:

> I felt like I had good relationships with the kids. I felt like the relationship just went above and beyond what I thought it could be, as far as, I mean, just seeing all the smiles in class. It's like wow. It's the same kid. It's just me asking something a little bit different, a little less daunting or a little less on the spot. The way that I ask it was I came over here to the small group and I asked it. I didn't ask in front of the class or I didn't ask where everybody could hear or instead of asking, "Where'd you get 15?" It's like, "Can you explain to me what you did on Number 7?" It's like, "Oh, I did this. I did the inverse." I was like, "Okay, good vocabulary." Now, I'm more supporting to my students that way because I know how to support them now. It's not just like, "No, wrong answer. You should have got [*sic*] 15."

Gino provided evidence of increased student enjoyment based on a nuanced question adjustment that engendered an impactful, and positive, student reaction. Gino's new question-asking strategy became internalized after he experienced evidence of success. In similar manner, Marie recounted evidence of successful student actions when she recounted:

> So by having that success, it gave me the confidence to actually change the way I teach and actually start asking deeper into my students' conceptual understanding. And after a few tries of that to see some measure of success, it builds on itself. And pretty soon it helped change my teaching style.

Marie excitedly reflected on witnessing repeated student success. This success built on itself and increased Marie's confidence to keep implementing new strategies in her classroom. Her quote suggested she internalized the value of her new learning based on observing her students' success. To claim she changed the way she taught represented the magnitude of her internalization because no one at her school required she use a new pedagogy. Deanne mirrored Marie's excitement when stating:

I think if there was something that you saw working on another campus or with other kids or something that worked really well in the lesson, then that was a motivation to do it in your room because you saw it actually working.

Deanne specifically mentioned increased motivation as a result of watching students succeed in the classroom. She continued to explain:

I made like 10 last year [referring to a new way to deliver a lesson] and I didn't have any to start with, so it was pretty intense. I guess that was a lot of work and I still did it. Yeah. Even if you perceive that it's going to, your new strategy is going to take a lot of time you're willing to do that if ... If I think it's going to be worth it. Well, I guess I mean obviously I want the kids to like it. I want them to learn something, I want it to work. I guess that's worth it to me if the kids like it, if the kids are into it, if they're going to learn, if they're going to get stuff from it then that's it, that's my job.

Deanne's willingness to spend valuable time creating new lessons, in the absence of a mandate, revealed her perceived value. This value translated into internalization as she willingly adopted a new teaching technique. Blake nicely summarized the power of student response when stating, "I was able to translate a lot of what I learned into the classroom pretty immediately, and seeing some positive results gave me even new value for what I had learned."

While positive student responses may well have engendered high levels of internalization, negative student responses similarly reduce or reverse the effects of internalization. For example, when referring to a new instructional practice, Kamace responded:

I think some years, it worked better. For instance, the breakout box. Last year, we did tons of breakouts. This year, we've done no breakouts because we didn't feel that matched the kids because the kids this year are really hard to control, and I didn't think that that kind of freedom would work in most of my classes. "Well, what's going to work best with this group this year?" Everything that you did last year is not going to work with this group this year. So, you got to be open to making some changes.

Kamace reminds us teachers will abandon an effective practice if they perceive negative student reactions. In this case, a negative student reaction negated the once-internalized belief that breakout boxes promoted enhanced learning. While Kamace admitted to ending her use of

breakout boxes based on current student behavior, she admitted a willingness to try the strategy

with a future class.

Epistemological Shift

        The second subtheme supporting internalization, epistemological shift, described how a

teacher changed their teaching paradigm. This change shifted the teacher's belief in how students

learned information. Once teachers changed their view on student learning, they shifted their

belief in how they should teach. Gino described his shift as:

> I was withholding information. Not intentionally, but I just wasn't letting my kids grow because they didn't know what to do and every time they ask a question, it's like, "Well, let's stick with this. Let's do this." I was trying to control information. Now, I'm like, man, that's really crazy that I was trying to control information. That's not how you learn. You don't tell a kid to stop asking questions. You don't do that. You don't control the information. You don't try to make this assignment to where there will never be any discussions. Now, I know discussions are good. I know how to take the discussion. I just know how to answer the discussion. I know how to support the district now. I'm like, "Okay, yeah, let's have this discussion."

Gino was willing to fundamentally change his instructional paradigm over time as he learned and

practiced new pedagogy. His perceived value of releasing control increased over time as he

began to see his students react favorably. Similarly, Marie described her shift as follows:

> [Lesson study] was my turning point, actually. Because to me, teaching before, teaching is like how I grew up and I tell the kids what to do step-by-step-by-step. Especially math. It's very procedural. Okay, you do this first and then this and this and this and this. Right? And when I went to [lesson study], they showed me it doesn't have to be that way. You have to see it more conceptually. Because if you can teach them the concepts, they'll be able to go through the procedure by themselves. It's like, "Oh." It's a change in thinking, and they showed me how to think about it, really. And that made a difference in the world for me. I'm truly, truly grateful, because like I said, they are what helped me reason more successful. And actually, they're basically what helped me to be a success, because right now I feel successful. My school actually wants me.

Marie described her internalization journey of realizing that a traditional model of instruction,

based in behaviorism, reflected one pedagogy. Her turning point occurred when she realized

inquiry-based pedagogy, focusing on conceptual understanding, increased her student

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achievement to the point of receiving recognition from her administration. Likewise, Elena observed:

> I think that's what I've really been successful in, is how I approach questioning my students now, then when I first started, instead of just the closed questioning. I've been able to get better at asking more open-ended questions that don't have maybe just one answer or a single answer, a right or wrong answer. And that has really, like I said, I've really been able to implement that a lot more, especially this year, since I've been in [algebra PD]. And that has helped, like I said, my student's thinking, and so I can really see now how they're understanding the material a lot more and they're making it their own, and it's giving them more confidence when they take their exams.

By asking open-ended questions, Elena increased student conceptual thinking. Additionally, Elena used student responses in a formative manner to make real-time instructional adjustments. She specifically mentioned increased student confidence as a consequence of her instructional shift.

In the last example, Sharon reported her shift took time as she stressed, "Well, most of the new strategies or collaborations, not that it's new, but do more of that and letting go of the control was hard for me, I did it over time." Sharon credited lesson study for helping her understand she could release control and let students problem-solve both on their own, and in collaboration with others. Seeing the evidence from lesson study helped her internalize positive student outcomes and that students were capable of learning from an inquiry-based approach. As an experienced teacher, with an established teaching paradigm, her shift required more time to internalize; however, according to her own admission, she successfully made the shift with support from lesson study. She voluntarily increased the use of new strategies as she became comfortable with new techniques and received continual reinforcement via student success.

As part of the triangulation process, I included multiple data sources to reinforce findings related to teachers' experiences of lesson study. The second data source, describing how teachers

experienced motivation, included a content analysis of teacher written reflections. The reflection

prompts that informed RQ2 were:

- How has your professional development experience helped you grow in being able to offer a rich learning experience?
- How did the professional development experience expand your depth of understanding of the concepts related to your area of teaching and how did this expanded depth of knowledge help you in your teaching?
- Describe reasons for applying for the algebra professional development?

This analysis produced one theme and three subthemes (see Table 29).

Table 29

Motivation Themes and Subthemes from Semi-Structured Interviews

Theme	Subtheme Informing Theme
VII. Internalization – process of acknowledging value and worth of behavior, thus leading to autonomous motivation	Value Recognition – teachers recognized the value of new paradigm and used it in their classroom Student Response – teacher's willingness to implement new pedagogy based on favorable or unfavorable student response Epistemological Shift– teacher changes teaching paradigm

Note. Information in table represents results from written reflections; it does not include information from semi-structured interviews.

Autonomous Motivation Theme VII: Internalization (Written Reflections)

Based on this analysis, the overarching theme of the written reflections was

internalization. Internalization referred to the process of consciously assimilating the value and

worth of new learning to the point one chooses to employ its use according to one's own

volition. The subthemes of (a) value recognition, (b) student response, and (c) epistemological

shift supported the theme of internalization.

Value Recognition

Value recognition occurred when teachers recognized the value and practicality of a new

paradigm or teaching strategy and considered it worthy of study and implementation. To

illustrate, Chloe revealed:

> The process that we use for lesson study is helpful because I try to keep these questions we look at in mind when planning and revising what we will do with a class. I always think about the questions they've answered, and how I can tell what they have taken away from the lesson.

Chloe expressed value in her learning from lesson study because she now focused on question strategies designed to elicit formative feedback. She has implemented this strategy in her classroom to ascertain how her students reacted to her lesson and how they interpreted understanding. Because she valued this strategy, she has voluntarily chosen to use it in her classroom. In the same way, Sharon explained:

> My [algebra PD] experience is about student thinking and guiding them to work together. It is modeled for us in our classroom, and we practice it in our lesson study. Algebraic and geometric thinking is the focus in the activities we have done in our groups in our class. This helps us translate it to our classroom as we break down problem-solving and use monitoring forms to predict students' patterns of thinking to isolate areas of concern.

Like Chloe, Sharon has experienced instructional strategies designed to promote student conceptual thinking and has internalized its value. As a result, she has implemented its use in her classroom. Additionally, her value recognition increased when she was able to practice using the techniques learned during lesson study.

Student Response

The second theme supporting internalization, student response, referred to increases in teacher inspiration to use new pedagogies/instructional strategies due to positive student responses. Student responses included (a) observable increases in student engagement, (b) confidence, and (c) academic achievement. Blake articulated this concept by suggesting, "Completely flipping the traditional model of the mathematics classroom has allowed my students to build experiences where they can understand and learn the mathematics context and actually have fun with the content." Blake's competence in his new strategies increased as a

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result of observing his students having fun in class while learning mathematical concepts. This competence continued to increase when he reported, "Every year that I've been in [algebra PD], my students have ultimately received the benefits, as their confidence in mathematics and assessment scores have increased." Recognizing increased student responses to new pedagogy validated the teacher's actions, thus leading to increased perceptions of competency. Elena experienced similar feelings as she asserted:

> I decided to continue for another year in the [algebra PD] program because I really feel that I grew exponentially as a teacher in terms of utilizing engagement tools that helped me be a more effective teacher that made my students more successful and confident in the classroom.

Witnessing her students become more successful and confident provided a powerful incentive to continue implementing new pedagogies as her competence improved. Interestingly, not only did she recognize increased competency in her skills, she noted similar increases in her student's competency as well.

Epistemological Shift

Epistemological shift represents the last subtheme supporting internalization. This shift explained how participants adjusted their teaching paradigm (i.e., how they believe students learn and how teachers should teach). This was either directly stated or assumed based on a teacher providing specific examples of adjustments to instruction. To illustrate, Marie claimed:

> This is a paradigm shift for me, as I've always used to think of teaching as something you do by teaching a step-by-step process. All by rote and memorization. But by teaching conceptually, students are actually gaining a deeper understanding of the mathematical concepts they need to know. And by gaining these deeper understandings, they gain more ability to tackle more complex problems.

This quote illustrated how Marie internalized the value of her new learning due to witnessing her students improve their problem-solving skills. Similarly, Chloe expressed an epistemological shift, as:

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I have let go of needing students to be quietly work[ing] by themselves. My students are now constantly talking, collaborating, and helping each other. Students do more tasks, which utilize and grow their problem-solving skills to make them successful with any topic. The lesson study process has helped me to understand how to use these math tasks appropriately and prepare to lead a discussion on student methods and thinking about the problems. This has also helped with the engagement and motivation issues in my classroom. Students are more willing to work because they can get help from one another in a supportive way. Students now know how to talk about the work they are doing and show somebody else how to see their process. The activities we do are more than just taking the notes and working on their papers.

This statement demonstrated a substantial shift in Chloe's pedagogical epistemology. She has changed her beliefs in how students learn, therefore, she has adjusted how she teaches to include (a) collaboration, (b) problem-solving, and (c) class discussions promoting conceptual understanding. This replaced her behavioristic approach of lecture and worksheets.

In conclusion, the content analysis of written reflections described the internalization process of the participants as they progressed through lesson study. The internalization process consisted of value recognition and positive student response, thus leading to an epistemological shift (see Table 30).

Table 30

Frequency Table for Motivation Subthemes

Theme		Internalization	
Subtheme	Value Recognition	Student Response	Epistemological Shift
Marie	8	5	4
Blake	6	5	4
Chloe	9	9	4
Kamace	4	4	4
Sharon	8	4	3
Elena	1	9	6
Gino	4	7	10
Deanne	3	1	2
Total	43	44	37

Note. Values reflect the number of times a participant referred to a subtheme in both the semi-structured interviews and written reflections; a zero indicates a participant did not refer to a subtheme.

Conclusion

In conclusion, this chapter answered two research questions related to teachers' perceptions of supportive contextual factors and motivation in the context of LSOA. The teachers perceived an increase in competence based on feeling an emerging proficiency in learning new pedagogy. The environmental and social contextual factors of (a) collective validation, (b) pedagogical substantiation, (c) acute feedback, and (d) pedagogical affirmation allowed teachers to sense a causal effect on student learning in their classrooms. Moreover, they satisfied a need to acquire pedagogical understanding to facilitate achieving an important personal goal. These contextual factors provided (a) positive feedback, (b) feelings of mastery, and (c) improved effectance. While lessons study promoted competence, it conversely created apprehension based on a lack of communication and vulnerability, thus lowering perceived feelings of competence, and yet, these feelings personified temporary conditions. The teachers consistently reported their learning outweighed temporary feelings of discomfort or irritation over communication issues.

In addition to elevating a sense of competence, teachers perceived the collaborative nature of lesson study as a powerful tool in facilitating relatedness. Teachers reported a high level of appreciation when collaboration led to creating lessons and ideas greater than the sum of their individual contributions. The contextual factors of (a) meaning negotiation and (b) collective solidarity promoted this synergy of idea creation. This contributed to the perceived "sense of being integral to a social organization beyond oneself" (Ryan & Deci, 2017, p. 11). Additionally, collaborative arrangements allowed teachers to feel socially connected through positive interpersonal connections with others. This connection promoted (a) effective

communication, (b) coordination, (c) balance of member contributions, (d) mutual support, (e) effort, and (f) cohesion.

While teachers cited positive interpersonal dynamics as a reason for increased learning, others communicated antithetical experiences. To illustrate, four teachers reported experiencing contentious interpersonal group dynamics, yet two participants credited that dynamic as improving their learning. These two reported contentious dialogues challenged ideas, instructional paradigms, and lesson designs but also created deeper learning opportunities. This challenge forced members to question their assumptions and deeply evaluate their epistemological beliefs. Conversely, two teachers reported contentious interactions created stress and limited their learning. Although they experienced discomfort, their groups performed and completed their live lessons. They both admitted to learning, but they also stressed their learning did not reach the full potential lesson study offered.

These experiences suggested challenging the ideas of others can lead to increased learning; however, individuals exhibit different levels of tolerance to contentious relationships. Ultimately, the collaborative experience of participants provided a safe space to negotiate ideas and experience learning in a supportive manner that created positive peer pressure to practice new teaching strategies with fidelity. Participants articulated the following as negatives aspects of collaboration: (a) collective rejection, (b) time, (c) limited experience, (d) overwhelming, and (e) conflict; however, much like apprehension, the teachers perceived these negatives as temporary distractions. Teachers perceived that the benefits of lesson study outweighed these annoyances.

Another benefit perceived by teachers included the large amount of choice associated with lesson study. The contextual factors surrounding choice were (a) growth preference, (b)

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voluntary participation, and (c) ownership of learning. Teachers reported the existence of many choices throughout their lesson study experience. These options, especially when designing live lessons, provided a sizable amount of personal ownership. This ownership facilitated two important functions related to autonomy. First, teachers perceived they controlled their actions, thus feeling volitional and self-regulating personal choices. Second, choice enabled teachers to align their values and authentic interest to their learning. This contextual factor enhanced their growth and sense of autonomy.

While teachers perceived contextual factors associated with lesson study provided opportunities to enhance competency, relatedness, and autonomy, they additionally perceived increased motivation to enact their learning. The findings suggested lesson study connected with teacher motivation by facilitating the process of internalization. This process manifested as teachers voluntarily implemented their newly learned pedagogy without an authoritative mandate because they enacted new teaching according to their own volition in their classrooms. This voluntary action occurred as a result of internalizing the value of new pedagogy. Teachers came to value their pedagogy after observing positive student reactions. These reactions included increased articulation of vocabulary and conceptual understanding, in addition to enhanced engagement, learning, confidence, and enjoyment. This reinforcement additionally supported an epistemological shift in which the teacher transformed their belief in how students learn, therefore, reifying their altered view of how they should teach.

The final chapter in this dissertation, Chapter 5, discusses the interpretation of the results in relation to PD and motivation literature. Limitations, recommendations for future research, and a final summary conclude the chapter.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter further develops the results by summarizing the study and interpreting the findings in terms of previous literature and practical application. Limitations, recommendations for future research, and a final summary conclude the chapter. The information in this chapter contextualizes findings in relation to previous research and presents an interpretation of meaning, thus informing theory, research, and practice of in-service teacher professional development (PD) relative to motivation.

Study Summary

Steady increases in state and federal accountability initiated this study because public school principals, acting as instructional leaders, must show continuous increases student achievement to meet accountability standards (Kim, 2018). When determining how to increase student achievement, Whitaker (2012) suggested principals make a simple choice; they either replace their teachers or they support existing staff. While this choice might prove tempting for some administrators, the reality reinforces the need to increase teacher effectiveness by providing in-service teacher PD. Moreover, studies suggesting student achievement may increase due to PD further underscores the need to support teachers (Carpenter et al., 1989; Darling-Hammond et al., 2009; Gallucci et al., 2010).

The responsibility of improving student achievement by means of PD often falls on the principal as they assume the role of instructional leader on their individual campus. This role demonstrates a critical link because the capacity, knowledge, and experience held by the principal greatly influences the degree of school success (Marzano et al., 2005). Therefore, informing principals by providing information to select and guide PD may increase the

likelihood of successful PD implementation, thus, increases in study achievement. In addition to making instructional decisions related to PD, principals might also consider emotional factors supporting teacher learning. This awareness connects to motivation, which according to Guskey (2002), can initiate failure if principals neglect motivational concerns and the teacher-change process. According to researchers (Guskey, 2002; Korthagen, 2017; Ross, 2014) principals, policymakers, and scholars often ignore motivation when implementing, developing, or studying PD efforts designed to increase student achievement. Furthermore, Shulman and Shulman (2004) have acknowledged teacher motivation underscores a major component of promoting successful PD results. Due to these gaps, this study centered on the following two research questions (RQs, along with subquestions (SQs) for RQ1):

- RQ1. How do teachers perceive the motivational contextual factors offered by lesson study with open approach (LSOA)?

    o SQ1. How do teachers experience competence when participating in LSOA?

    o SQ2. How do teachers experience relatedness when participating in LSOA?

    o SQ3. How do teachers experience autonomy when participating in LSOA?

- RQ2. In what ways does lesson study with open approach connect with teacher motivation?

Because this research embodied the importance of context, using Yin's (2018) conceptualization of case study promoted an appropriate methodological fit. To illustrate, the results described how participants experienced the phenomena of motivation in the context of lesson study. Lesson study provided specific environmental conditions that directly influenced the teachers' experience with motivation.

The results associated with the RQs suggested teachers perceived lesson study as capable of providing social and environmental factors influencing motivation. Using the lens of self-determination theory (SDT), teachers reported increased feelings of (a) competence,

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(b) relatedness, and (c) autonomy. By promoting and nurturing these three psychological needs, teachers perceived an increased sense of value in their new learning, thus encouraging the internalization of new pedagogy. This internalization led to perceived feelings of autonomous motivation.

These results from the current study could inform educational stakeholders who seek to understand the elements of lesson study that promote the internalization of teacher learning. The results embody significance because individuals motivated from an autonomous perspective demonstrate higher levels of (a) focus, (b) commitment, and (c) desire (Deci & Ryan, 2008). These characteristics lead to better enactment and sustained effort when implementing new teaching strategies, thus strengthening the goal of increasing student achievement. Additionally, these results identify contextual factors that increase and/or decrease the three psychosocial needs leading to internalization. By understanding these contextual factors, principals can deliberately influence the learning environment to promote teacher motivation in the context of PD. In addition to informing policy at the practitioner level, these results add to the limited body of current scholarship on this topic.

Interpretation of Results

Chapter 4 discussed inductive themes generated from the combined analysis of (a) semi-structured interviews, (b) written reflections, and the (c) Teamwork Quality (TWQ) survey. The themes identified were: (a) emerging proficiency, (b) apprehension, (c) synergy, (d) minor barriers, (e) interpersonal dynamics, (f) volition, and (g) internalization. These themes personified the lived experiences of secondary mathematics teachers who participated in an algebra PD using LSOA. Together, these themes inform social and contextual factors shaping the

psychological needs and internationalization, which ultimately impact motivation. The following interpretation of these themes provides meaning in the greater context of teacher learning.

Competence Theme I: Emerging Proficiency

As teachers participated in the lesson study process, they reported an emerging proficiency described as experiencing feelings of success as a result of trusting their new learning and developing a sense of confidence in understanding how to design and implement lessons. Emerging proficiency exemplified competence as teachers began satisfying the need to influence student learning with causal exactness (i.e., effectance). Feelings of pedagogical substantiation and acute feedback greatly increased these feelings as teachers observed and personally experienced successful teaching. Pedagogical substantiation and acute feedback increased effectance when participants learned how to enact inquiry-based instruction with fidelity. By practicing and receiving feedback on what constituted effective and ineffective techniques, participants developed a better understanding of causal actions that led to desired outcomes. The opportunity to revise lessons after multiple peer-reflection conferences increased effectance understanding. By experiencing successful teaching, participants reported a perceived surge in competence.

Perceived increases in competence align with Deci and Ryan (2008) who reported encouraging performance feedback can improve intrinsic-like motivation. The increase in this motivation occurs due to enhanced feelings of competence that satisfy competence needs. Conversely, Deci and Ryan reminded us negative feedback lowers feelings of intrinsic motivation. However, positive feedback increases intrinsic motivation only if the person perceived the feedback under autonomous conditions. For example, if a person receives positive

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feedback under controlling conditions or from a controlling tone, they essentially perceive the feedback as negative, thus reducing feelings of competence.

In the current study, acute feedback and pedagogical validation performed the function of encouraging performance feedback. The context in which participants delivered feedback characterized a noncontrolling environment with the result that the teachers reported feeling successful. However, Deci and Ryan's (2008) claim that negative feedback could lower intrinsic motivation held true to this study's results. To illustrate, participants reported feeling less successful when the group rejected an individual's ideas and suggestions. This collective rejection materialized as minimal emotional distress or hurt feelings. Although reported as ultimately nonconsequential to learning success, this situation temporarily reduced perceived feelings of competence.

Scholars reinforced the emerging proficiency theme by stressing the importance of the live lesson (Murata, 2011) and providing space to practice (Takahashi, 2015). Murata asserted the live lesson, followed by reflection, provided space for teachers to collect information focused on student learning. He reinforced the critical nature of this phase because it led to understanding about how students interpreted the lesson; this understanding considered the degree of fit between intended and actual learning. Murata's explanation of the critical nature of this phase dovetailed with the subjects of the present study as they reported the reflection phase offered the greatest degree of competence satisfaction.

Ryan and Deci (2017) stressed competence grows when one has the perception of manipulating or controlling the environment to produce specific outcomes related to personally important goals. When one perceives the capability to maintain and/or enact causal effects of outcomes, they express effectance. Once teachers in the present study practiced new pedagogy

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during the live lesson, they developed effectance when they gained confidence in their skills to intentionally create desired learning outcomes. After developing a sense of control by deliberately engineering specific learning outcomes, they satisfied the need to influence their environment. Seven of the eight teachers reported the reflection phase increased feelings of success in comparison to lesson development and the live teaching phase.

Additionally, Takahashi (2015) emphasized two important concepts related to PD; first, he claimed teachers needed instruction supporting new learning. Secondly, teachers should have space to practice teaching new techniques. Much like learning any new skill, a person should have the opportunity to practice the skill in order to gain confidence. In like manner, the participants in the present study found the live lesson invaluable because it allowed them to practice and explore new teaching techniques in a safe environment. This practice space increased feelings of competence based on two components. First, teachers observed positive student reactions; and second, they practiced teaching the lesson, thus increasing their belief in their own ability to facilitate the new pedagogy.

Competence Theme II: Apprehension

The theme of apprehension reflects Takahashi's (2015) concerns related to culture. Takahashi reminds us Japanese educators have practiced lesson study in Japan for over 140 years in a specific culture differing from American culture. According to Takahashi, American teachers generally avoid collaborative lesson planning nor do they observe each other's classrooms. Therefore, the apprehension reported in the present study may originate from pervasive cultural norms related to planning in isolation and associating observations with administrator performance evaluations.

During the live lessons, teachers felt a temporary loss of competence. This reduction,

articulated as apprehension, manifested as feeling vulnerable. Several participants felt anxious before teaching the live lesson because they wanted to appear skilled and competent in front of their peers. Feelings of insecurity developed as a reaction to potentially feeling judged as inferior by other teachers. Hart and Carriere (2011) found similar findings in their research involving lesson study. They determined teachers who taught the live lesson became defensive during the reflection phase when they perceived criticism personally. In the present study, feeling judged subsided once the participant who had assume the teaching role realized others passed judgement on the collaboratively-created lesson, not the person delivering the lesson. As teachers became more experienced, the fear of judgement diminished.

In addition to reporting findings of judgement, Hart and Carriere (2011) revealed teachers struggled to have deep conversations about pedagogy; they discovered teachers did not take the lead in their own learning or goal selection. In similar fashion, Fernandez et al., (2003) reported teachers enacting lesson study engaged in shallow and superficial pedagogical discussion. However, these concerns did not materialize in the present study. The teachers involved in the current study reported engaging in deep and meaningful conversations.

As a result, a principal assuming the role of leading a lesson study PD in America might anticipate teacher apprehension as an expected reaction. Emphasizing student learning and creating protocols for observation roles could ameliorate this apprehension. Characterized as a normal reaction by the teachers, the participants in the present study admitted feeling nervous when teaching in front of peers.

In conclusion, the themes of emerging proficiency and apprehension both promoted and reduced perceived feelings of competence. Teachers in the current study reported an elevated sense of confidence and success when they received positive feedback in the form of collective

validation as other teachers expressed approval or admiration of their ideas. Receiving acute feedback from mathematics peers that improved instruction and provided direct guidance increased feelings of success, as well. Teachers gained confidence and feelings of effectance motivation when they personally observed and experienced student learning during the live lessons. Ryan and Deci (2017) reported teachers need to meet epistemic motive needs. This need characterizes the desire to learn skills needed to achieve effectance in one's environment. Teachers expressed a desire to obtain pedagogical certainty and/or self-assurance. Essentially, they sought pedagogical affirmation, which describes meeting the need to understand what and how to teach mathematics effectively. Teachers expressed a passion to satisfy this need in reference to choosing to participate in the algebra PD. After participating in the lesson study, teachers reported meeting this need due to their learning and personally observing positive student results. Therefore, teachers perceived epistemic learning as articulated by Ryan and Deci, thus contributing to increased competence.

Though the participants of this study reported increases in perceived competence, they also reported perceptions of reductions in competence. Vulnerability and lack of communication represented contextual factors reducing felt competence. However, these factors reduced competence temporarily. Once teachers practiced the lesson study cycle, vulnerability subsided and they reported that learning outweighed temporary feelings of discomfort. In similar fashion, stress induced by communication problems likewise represented temporary annoyances.

While the study participants collectively felt confident and successful, thus satisfying the need for competence, Ryan and Deci (2000) remind us competence alone will not lead to intrinsic-like motivation. They emphasized individuals must also feel socially connected in a safe and caring environment. Known as relatedness, individuals should (a) satisfy the need to

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authentically belong to a group, (b) feel meaningful among others, and (c) contribute to the functioning of the team. Findings associated with relatedness include the themes of (a) synergy, (b) minor barriers, and (c) interpersonal dynamics.

Relatedness Theme III: Synergy

Synergy embodied communication among peers that promoted higher levels of pedagogical understanding and idea creation related to lesson development and enactment. Participants mentioned collaborative discussions that led to ideas beyond what one person could create on their own. This creation process manifested through meaning negotiation as participants discussed how to process and operationalize inquiry-based pedagogy. This meaning negotiation created space for teachers to (a) challenge prior beliefs, (b) push for deeper understanding, and (c) evaluate alignment between lesson design and inquiry-based pedagogy. The teachers in the current study perceived meaning negotiation as a critical element of their learning. Additionally, lesson study provided space for meaning negotiation at all three stages of the lesson study process, thus providing continuous opportunities for synergistic communication.

Teachers reported collective solidarity and group encouragement, during the learning process, supported the meaning negotiation process. Every participant reported that inquiry-based pedagogy constituted a dramatic shift in thinking compared to procedural teaching. Therefore, every participant experienced the need to negotiate understanding of new pedagogy based on their prior experiences and imperfect pedagogical knowledge. As a result, each participant experienced similar learning challenges. Experiencing this challenge collectively placed everyone in equal positions; no one person had a pedagogical advantage over the other, so they relied on each other as they worked to enact and revise lessons. This made risk-taking part of the collective norm, as all members contributed and participated in initiating a drastically new

teaching strategy. Risk-taking as a collective norm created a safe space because everyone faced similar challenges. Undergoing this learning collectively characterized a less daunting environment. The collective cooperation required every member to endorse a common goal and act in a unified manner to achieve their agreed-upon outcome.

Won (2017) supported these findings when reporting teachers who participated in a lesson study valued learning from others who approached understanding from different perspectives. When teachers explained their thoughts, it stretched the thinking of others and tested their pedagogical values and baselines. Moreover, Won suggested collaborative sense-making promoted the teacher paradigmatic shift process as teachers felt compelled to follow agreed-upon norms.

Relatedness Theme IV: Minor Barriers

Although participants perceived beneficial effects related to working in cooperation, they additionally reported problematic areas associated with collaboration. For example, participants identified (a) collective rejection, (b) time constraints, (c) limited experience, and (d) feeling overwhelmed as obstructions, which temporarily impeded task-completion goals.

According to Clark (1994), a critical aspect of ensuring successful mathematics PD includes the removal of barriers. Clark insisted school leaders must remove (a) external, (b) internal, and (c) affective barriers that might inhibit teacher learning and their ability to authentically implement new teaching strategies. External barriers typified a lack of long-term support, while internal barriers included time restrictions that limited opportunities for teachers to practice and experience new learning. Lastly, affective barriers included ignoring the emotional and motivational needs of teachers.

Barriers reported in the present study included time commitment and limited experience,

which ultimately centered on providing opportunities. In other words, participants reported the lesson study process required a noteworthy time commitment and a portion of teachers expressed disappointment with the limited amount of live-lesson teaching opportunities. Teachers wanted to experience participating in live lessons at a higher frequency.

When considering the length of PD, researchers (Desimone & Garet, 2015; Wayne, et al., 2008) insisted sustained duration characterized a critical element of successful PD. Scher and O'Reilly (2009) further clarified this suggestion in their meta-analysis by stating teachers participating in a two-year mathematics PD exhibited a higher effect size of .59, when compared to teachers who received one year of PD exemplifying an effect size of .14. Likewise, Marsh, McCombs, Martorell, and the Rand Corporation (2012) suggested measuring the effects of PD after one year of implementation demonstrated an insufficient amount of time to determine effectiveness. In the same way, Campbell and Malkus (2011) determined mathematics-focused PD, using instructional coaches, did not reflect increases in student achievement after one year. However, PD delivered by instructional coaches did achieve a significant impact on student achievement after the second and third year of implementation. Although these studies did not involve lesson study, they suggested PD initiatives might consider sustained duration from the perspective of multiple years.

In addition to time and limited experience, participants in the current study experienced collective rejection and feeling overwhelmed. These affective concerns, as articulated by Clark (1995), add to the existing body of literature, as there is an absence of lesson study research addressing these specific barriers.

The barriers reported by participants represented slight inconveniences that did not reduce the quality of learning. From a frequency perspective, the issue of time (two participants),

limited experience (three participants), feeling overwhelmed (two participants), and collective

rejection (two participants) represented a small proportion of participant experience. None of the

teachers who mentioned these barriers considered them as significantly harmful to their learning.

Although these barriers ultimately proved innocuous to learning in the context of the current

study, they represent contextual factors worth noting. Belbin (2007) supported this claim when

reinforcing, "Knowing what to avoid can become one of the arts in good design" (p. 74). The

barriers experienced by the teachers in the algebra PD represent contextual factors worth noting;

therefore, lesson study facilitators may work to intentionally ameliorate these barriers when

planning and implementing a lesson study.

Relatedness Theme V: Interpersonal Dynamics

Interaction quality among group members encompassed the theme of interpersonal

dynamics, which greatly contributed to participants' sense of relatedness. As one might expect,

teachers in the present study reported positive interpersonal dynamics, which promoted group

connectedness and feelings of harmonious relationships. Participants credited harmonious group

interactions with creating a safe and comfortable learning environment. They reported that

interacting in this environment advanced effective learning and, in contrast, assumed

membership in contentious collaborative environments would lead to less learning. Won's

(2017) lesson-study research supported this finding when stating teachers enjoyed elevated

sense-making opportunities when working in collaboration. However, Won emphasized teachers

relished learning in collaborative environments so long as they experienced safe and accepting

interactions.

Though participants in the current study reported positive interpersonal dynamics

enhanced learning, others offered alternative explanations. For example, four participants

affirmed membership in contentious groups. They described contention as inharmonious interactions characterized by diminished feelings of connectedness and discord. To illustrate, Gino and Marie described their harmonious team experience as pleasant and felt a sense of family-like belonging. However, they both admitted increased learning occurred after joining contentious groups. Learning increased when members challenged ideas, thus causing members to fully articulate and defend pedagogical decisions and suggestions. This culture of challenging and defending ideas, although stressful at times, caused deeper thinking and higher levels of learning.

In 2007, Belbin published research related to why teams fail or succeed, and discovered a noteworthy point that may explain Gino and Marie's experiences. Belbin revealed certain unsuccessful teams demonstrated task production could actually include high rates of harmony among members. Belbin reported certain unsuccessful teams exhibited high morale and positive interpersonal dynamics, despite ultimately failing to achieve their goal. Poor morale or contentious interpersonal dynamics did not cause task failure. In fact, certain failing teams reported their collaborative experience as happy and enjoyed working with one another often leading to the phrase, "They went down smiling" (Belbin, 2007, p. 75). Belbin's results additionally claimed contentious interpersonal conflict, if managed appropriately, enhanced a team's performance. Belbin's findings suggested properly functioning teams should reflect balance between positive and contentious interpersonal dynamics.

In addition to Belbin's (2007) theory, Wheelan (2005) offers a potential explanation related to Gino and Marie's experiences. Wheelan claims teams develop through a series of phases that determine their level of performance capability that includes (a) dependency and inclusion, (b) counterdependency and fight, (c) trust and structure, and (d) work and termination.

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Specifically, Wheelan reminds us during the second stage of group development, members work to seek clarity and establish (a) goals, (b) roles, (c) values, (d) norms, (e) boundaries, and (f) a social hierarchy. This process could involve a certain level of conflict reflecting hostile and conflictual dialogue. Wheelan argues, "In short, if the group is to be successful, members must create a unified group culture and structure during stage two" (p. 62). Wheelan views this process as critical in reaching the next level of group development concentrating on task production. Conflict can forge this critical process by creating a sense of urgency and honest communication that leads to a genuine development of culture and social structure. If group members ignore conflict and honest debate due to polite discourse, the group can develop a superficial culture, values, and norms that lack substance and a reduction in group ownership. This can lead to weak shared values and cohesion. If conflict is present and managed appropriately, groups can establish strong values and cohesion that lead to a strong culture and processes that engender member ownership.

Though Gino and Marie explained harmonious groups promoted happy and pleasant feelings, a lack of challenging dialogue stifled their learning. They reported contentious groups engendered stressful interactions when dialogue became heated, but the exchanges added depth of understanding related to their new learning. The results of the current study similarly suggest balance between harmony and challenging dialogue may create optimal learning situations, creating healthy group dynamics during the second stage of group development.

While Gino and Marie believed contentious interpersonal dynamics enhanced their learning, Kamace and Deanne offered conflicting perspectives. Kamace and Deanne reported trivial arguing based on inconsequential issues instead of challenging dialogue in their groups. Kamace felt arguing about role assignments exemplified insignificant issues that occupied

valuable time, thus increasing feelings of frustration. Deanne reported frustration based on disagreements centered on constant conflict, late arrivals, and lack of follow-through. In the end, Kamace and Deanne admitted they gained valuable knowledge from their lesson study experience but felt the contentious nature of their groups limited their learning potential.

The distinguishing characteristic defining the different perspectives between the two pairs centers on interpretation of intent. Gino and Marie may have believed their group's conflict focused on content and pedagogical decision-making because they did not consider challenging dialogue as personal attacks. However, Kamace and Deanne may have considered contentious dialogue as personally frustrating because it was delivered with unpleasant intent. Again, this centers on interpretation of intent because Gino, Kamace, and Deanne were members of the same group and expressed contrasting reactions to conflictual interaction.

Wheelan (2005) supports this claim by suggesting Stage 2 (counterdependency and fight), conflict materializes in two distinct forms. Wheelan identified one as productive to group development and the other as detrimental. For example, substantive conflict refers to disagreements related to the group's tasks or goals. This includes disagreements related to group norms, mission, and how to achieve the goals. Interpersonal conflict, however, refers to negative feelings or personal animosities held between members unrelated to perceived task disagreements. Interpersonal conflict reduces team cohesion, satisfaction, productivity, and cooperation, while substantive conflict leads to higher levels of cohesion and trust.

The difference between Gino and Marie's interpretation of conflict and Kamace and Deanne's interpretation may rest on Wheelan's (2005) conceptualization of substantive and interpersonal conflict. Gino and Marie may have interpreted the contentious dialogue in their groups as substantive, thus focusing on enhancing group goals. This could explain why Gino and

Marie claimed challenging dialogue added depth to their learning. Moreover, Kamace and Deanne's interpretation of conflict may rest on Wheelan's conceptualization of interpersonal conflict, which could explain their feelings of frustration and reduced levels of cohesion satisfaction.

Wheelan (2005) described reactions to group conflict as, "Some groups navigate their conflicts well, and others disband or become dysfunctional by dealing with their differences ineffectively" (p. 75). The findings in the current study suggest not only do groups navigate conflict, by extension, individuals within groups similarly navigate conflict. This suggests individuals within groups interpret disagreements through the lens of substantive and interpersonal conflict differently. Gino participated in Kamace and Deanne's group during the second year and interpreted conflict differently. While Gino interpreted disagreements through the lens of substantive conflict that enhanced his learning, Kamace and Deanne interpreted the same disagreements though interpersonal conflict leading to stifled learning.

Wheelan's (2005) conceptualization of conflict interpretation clarified the contrasting findings of the current study related to contentious interpersonal dynamics and how those dynamics influenced collaborative learning within lesson study groups. In addition to identifying contrasting forms of conflict, Wheelan offered suggestions to ameliorate each form. She mentions conflict resolution may well reduce interpersonal conflict, while conflict management might assist with task-related conflict. Wheelan's recommendations inform lesson study facilitators seeking intervention to protect or enhance the relatedness needs of lesson study participants.

Overall, participants perceived their collaborative experience in lesson study as beneficial in creating a safe space to learn. They appreciated and valued the opportunity to negotiate

meaning in all phases of the lesson study cycle. This allowed participants to develop ideas and pedagogical understanding at a high level. Collective solidarity framed meaning negotiation in a context of support, as all members experienced new learning. Additionally, participants reported harmonious interactions among collaborative teammates enhanced their learning as they progressively explored new pedagogy. Therefore, social and environmental factors promoting relatedness included providing space and time for participants to negotiate meaning in relaxed environments.

Participants perceived factors promoting social connectedness; yet, they additionally experienced factors leading to reductions in felt relatedness. Although collaboration offered many learning benefits, it can similarly produce aggravation and member frustration. Social and environmental factors leading to decreased feelings of relatedness included collective rejection, feeling overwhelmed, and understanding the necessary time commitments. Lesson study facilitators may anticipate these barriers by providing time for teacher collaboration, bringing awareness to collective rejection, and stressing the need to narrow the focus when faced with innumerable suggestions. Although these barriers represented a negligible impact on feelings of relatedness, contentious interpersonal dynamics characterized the largest threat to successful lesson study implementation.

To further explain this threat, two participants reported that contentious interpersonal group dynamics compromised their learning. This concern demonstrated the greatest threat to meeting the need for relatedness. This threat is relative, however, because the two teachers reported learning from their experience, but both felt they could have learned more if their group did not encounter contentious interactions. Therefore, lesson study facilitators might frequently monitor interpersonal dynamics and offer support when necessary. Wheelan (2005)

recommended using either conflict resolution or conflict management as support for teams experiencing interpersonal and substantive conflict, respectively. Additionally, Smith, Polglase, and Parry (2012) determined the most valuable result of their research centered on educating students about group roles and how group dynamics develop. They stated, "Moreover, the acknowledgement that disagreements and clashes between group members are perfectly normal and not necessarily the fault of any individual helped to de-personalize disagreements and bred an atmosphere of tolerance within the cohort." (Smith et al., 2012, p. 587). This education helped students understand the dynamics of a healthy group compared to that of a dysfunctional dynamic; therefore, lesson study facilitators could consider similar support during initial stages of implementation to promote balance between positive and contentious interpersonal dynamics.

Although most study participants perceived learning in a safe and supportive environment, thus satisfying relatedness needs, Ryan and Deci (2000) remind us competence and relatedness alone will not lead to intrinsic-like motivation. They emphasized individuals must also meet the need to satisfy autonomy. Without autonomy, meeting the needs of competence and relatedness alone will not increase motivation. Teachers experiencing competence and relatedness can exhibit low motivation if they feel overly controlled by an external figure of authority. This loss of autonomy could cause a drop in embracing and/or enacting new learning in their classrooms.

Autonomy Theme VI: Volition

Teachers reported many choices when engaging in the lesson study cycle. This included options in lesson content, design activities, and manipulatives, as well as role and data-collection methods. They chose lesson adjustments based on data and enjoyed the flexibility to implement these adjustments as they saw fit. These examples of choice supported the opportunity to satisfy

needs associated with autonomy. Teachers perceived a high level of opportunities to make decisions based on their own volition, due to the voluntary nature of the algebra PD program and growth-preference options. Additionally, teachers reported a high degree of perceived ownership in their learning as a result of myriad choices.

These results align with Gorozidis and Papaioannou (2014) who reported teachers participating in PD increased perceived feelings of autonomy when they had (a) choice, (b) input, and (c) flexibility. Additionally, Gorozidis and Papaioannou claimed teachers wanted to satisfy the need to customize instructional initiatives to meet the needs of their specific students in their unique classrooms. Lam et al. (2010) further illustrate this point when they argued teachers appreciated opportunities to provide input on the content of PD, thus employing professional judgement when applying new learning in their classrooms. Lam et al., concluded teachers who felt pressure to comply with PD mandates, in the absence of flexibility, reduced intrinsic-like motivation to implement new strategies. Together, these two studies reinforce that intrinsic-like motivation increases when teachers feel a sense of control in customizing instructional initiatives to meet the individual needs of their students.

Whereas choice to customize instructional initiatives increase motivation, Murata (2011) reminds us that adjustments made to lesson study should not undermine its foundational elements. Murata emphasized the live or research lesson makes lesson study unique in comparison to other PD approaches. Additionally, he calls for future research to identify key elements that define lesson study characteristics, so subtle adjustments do not substantially change the essence of how teachers learn during lesson study cycles. Crandall et al., (1982) reinforced Murata's warning by noting PD initiatives attempting to garner teacher support by allowing them to make decisions related to PD design could result in failure due to modifications

that change the essence of specific approaches. Therefore, Crandall (1983) recommended staff

developers avoid teacher input related to design features of PD frameworks. Crandall suggested

teachers exercise input after they practiced new learning in their classrooms. Lesson study

addresses this issue because teachers have many choice options as collaboration underscores the

framework of the approach. As long as the cycles of lesson study remain true-to-form, teachers

have autonomous opportunities without compromising the framework.

  While Murata (2011) emphasized adherence to the foundational elements of lesson study,

Clark's (1994) articulation of effective mathematics PD supports the current study's findings.

Clark espoused PD should provide opportunities for some degree of choice. He argued teachers

are more likely to demonstrate a change in teaching if they recognized new strategies as

beneficial to their students. This recognition increased if teachers could choose the topic or

subject of their new learning. While this choice of topic increased motivation to enact new

classroom strategies, Clark advised choice must also fit within the expectations of staff

developers or campus administrators. Therefore, lesson study facilitators should avoid modifying

the procedures or actions of each cycle but could consider allowable choices related to content

and lesson design/lesson activities and their resulting adjustments.

  In addition, Clark (1994) reinforced the importance of teacher commitment when

initiating PD. He suggested teacher commitment increased when teachers reflected about

positive student reactions. Commitment increased when teachers felt supported by other teachers

and administrators. Clark concluded teachers were more likely to change their epistemological

teaching beliefs if their learning aligned with perceived student needs. This alignment greatly

increased when teachers incorporated choice in how they implemented their new learning. In

other words, the ability of choice—to a certain level—enhanced teacher ownership and buy-in,

thus increasing the likelihood of authentic enactment of new learning.

The participants in the current study supported Clark's (1994) recommendations for mathematics PD. To illustrate, teachers reported choice in determining lessons, activities, roles and so forth increased the worth and value of their personal learning goals. This choice facilitated teacher, buy-in, thus leading to a sense of ownership among participants. This sense of ownership increased teacher commitment, thus supporting Clark's claims. However, this study's findings extended Clark's suggestions by including growth preference. Participants reported appreciation in the ability to self-select their level of growth based on available choices. This allowed teachers to challenge themselves at appropriate levels based on their personal comfort zone. They mentioned making choices to place themselves in learning positions based on their own volition. This finding extends Clark's suggestions by promoting choice in growth preference. Not only did teachers have the choice to select the topic or subject of their new learning, they self-selected the depth of learning and level of participation.

In summation, participants in the present study reported perceived feelings of autonomy. Participants articulated autonomy based on (a) volunteering for the program, (b) self-selecting their level of growth preference, and (c) developing a sense of ownership based on lesson choice options. These findings support the claims of various researchers (Clark, 1994; Gorozidis & Papaioannou, 2014; Lam et al., 2010) while extending Clark's mathematics best-practice claims. These autonomy-based findings reflect meaningful implications because intrinsic-like motivation cannot exist in a vacuum (Ryan & Deci, 2000). Individuals exhibiting healthy development, well-being, persistence, and performance (i.e., intrinsic-like motivation) must satisfy their competence, relatedness, and autonomy needs. If these needs are not met, teachers could exhibit

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a lack of persistence and may provide poor performance in relation to task completion and quality.

To support this claim, I argue the participants of this study satisfied their psychological needs because they volunteered to participate for a second year. Based on participant qualitative data, they expressed interest in learning about mathematics pedagogy, which provided motivation to volunteer for the program initially. It is fair to suggest the participants began their learning process from a motivated perspective; however, after participating in the algebra PD for a year, they made the conscious decision to return and participate for a second year. The decision to return demonstrates the teachers maintained, if not increased, their motivation. Had their emotional and motivational needs not been met, the likelihood of the participants returning for a second year is unlikely.

Autonomous Motivation Theme VII: Internalization

The process of internalization underscores intrinsic-like motivation and exists only when an individual satisfies the three psychological needs. Being in an environment that promotes and encourages the needs of competence, relatedness, and autonomy through social and contextual factors greatly increases opportunities for individuals to experience intrinsic-like motivation. Ryan and Deci (2017) suggest once an individual satisfies their psychological needs, they can incorporate the value of a behavior into one's nature so strongly they choose to act on their own volition. In terms of PD, the goal of new learning should center on creating opportunities for teachers that intentionally promote positive contextual factors to increase these feelings of competence, relatedness, and autonomy. A similar but concurrent PD goal includes facilitating a process that encourages an increase in valuing new learning so that teachers internalize worth; they need to believe new teaching strategies will benefit their students, so they authentically use

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new practices in their classrooms according to their own volition. This process of internalization often takes the form of an epistemological shift, which encourages a change in teaching paradigm. PD that promotes internalization in an autonomous context results in enhanced persistence, creativity, excitement, interest, and confidence when learning new pedagogy (Deci & Ryan, 2008).

Based on the current study, the contextual factors promoting internalization were (a) value recognition and (b) student response. The participants often mentioned an increased feeling of value after they observed positive student responses. In other words, if teachers observed new pedagogical strategies work for their students or other teachers' students, they internalized its worth as credible and an accepted truth. This result supports Hargreaves' (2005) claim that teachers make pedagogical decisions based on their students' best interests. When teachers reflect on changing their paradigm, their change in behavior should provide a positive benefit for their students. If they believe new teaching strategies help their students, motivation increases due to the emotional bond underscoring the relationship with their students. Hargreaves asserted teachers connect with their students emotionally; therefore, they make decisions based on helping students achieve and improve because they care about them from an emotional perspective. Teachers base their instructional decisions on meeting student needs; when they accomplish that goal, teachers feel a strong sense of satisfaction. The results of the present study support this claim, as teachers reported student success reified their belief in the effectiveness of new pedagogy. However, the opposite held true; if teachers felt a new strategy did not help their students, they expressed a willingness to abandon the practice. Although teachers mentioned a willingness to abandon ineffective practices based on negative student reaction, a clear majority of teachers acknowledged changing their instructional practices.

Teachers in the current study affirmed not only learning new pedagogy, they described changing how they thought students learned, thus providing the antecedent to adjust their teaching paradigm. This shift in epistemological beliefs initiated authentic change in how teachers operationalized mathematics curriculum. Participants emphasized the dramatic shift between procedural teaching and inquiry-based teaching that focused on conceptual understanding. They appreciated the instructional supports, as offered by algebra PD, associated with their new learning to bolster inquiry-based teaching. In the end, participants reported their PD, implemented through the framework of LSOA, provided the structure, practice, and feedback necessary to orchestrate an epistemological shift in thinking.

This result supports Kadroon and Inprasitha (2013), who espoused teachers develop cultural teaching values and epistemologies over time, based on personal experiences. These values become the filter that guides all instructional and pedagogical decisions; therefore, highlighting the importance of a teacher's epistemological beliefs. This explains their claim that, "Any significant development in mathematics education probably implies a change in values" (Kadroon & Inprasitha, 2013, p. 102). Their research on LSOA suggests a teacher's epistemological paradigm can change when they participant in lesson study using an open approach lesson cycle. Their study suggested teachers who repeatedly practice lesson study and receive feedback not only increase student mathematics conceptual understanding, they shift their cultural teaching values. The participants in the current study experienced epistemological shifts in mathematics teaching as described in Kadroon and Inprasitha's study. To further explain teachers' perceptions of epistemological shift, examining Guskey's (2002) change model illustrates a worthy endeavor.

According to Guskey (2002), PD efforts often fail due to ignoring teacher motivation and

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the teacher-change. By neglecting to address these two specific needs, principals and other PD providers may fail to meet the PD goal of bringing about "change in the classroom practices of teachers, in their attitudes and beliefs, and in the learning outcomes of students" (Guskey, 2002, p. 381). Moreover, Guskey argues teachers do not change their beliefs during initial planning if they provide input or receive information purporting future success, they change their beliefs once they observe clear evidence of improved student learning outcomes. Gusky offered the following model to describe how teachers changed their beliefs and attitudes related to instructional paradigms (see Figure 4).
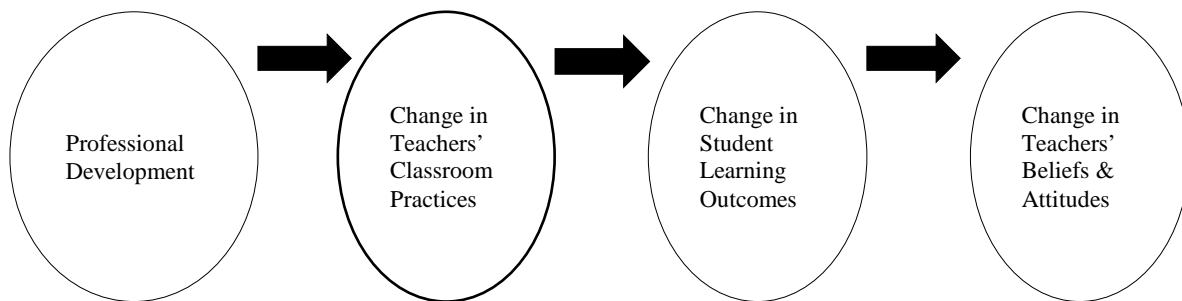

Figure 4. Professional development and teacher change (Guskey, 2002, p. 383).

The results of the current study dovetail with Guskey's (2002) model and similarly provide evidence that meaningful change in a teacher's beliefs, attitude, and epistemological paradigm occurred after observing positive student reactions. To illustrate, participants of the current study received PD, centered on the inquiry-based lesson model, and then applied the new pedagogy in their classrooms. Once teachers observed their students enjoying the lessons and performing at higher academic levels with increased confidence, the participants reported a change in epistemological orientation. They consistently reported (a) increased mathematics conceptual discussions, (b) cooperative learning, and (c) inquiry-based instruction in their classrooms, which replaced their previous traditional instruction.

Although the current study is supported Guskey's (2002) change model, it further

expanded his conceptualization of the "Change in Teachers' Classroom Practices" (p. 383) phase. To demonstrate, the theme of emerging proficiency described how teachers gained competence in trusting their new pedagogy and learning how to enact it in their classroom. Gaining trust proved critical because teachers reported being surprised when they observed students successfully constructing their own interpretations of mathematical concepts. This period of personally observing successful student engagement provided pedagogical substantiation, which gave teachers a firm conviction, trust, and faith that students at the middle-school level were capable of learning in an inquiry-based environment. This provided evidence the pedagogy worked, but the live lesson additionally offered evidence the teacher could provide such instruction. The live lesson with feedback supplied pedagogical substantiation by revealing the pedagogy worked and the teacher could successfully enact such pedagogy.

Experiencing successful pedagogical implementation and believing in their capability to teach inquiry-based instruction provided feelings of competence, giving teachers the inspiration and courage to implement new learning. Being able to practice, experience feedback, and reteach provided opportunities to practice a new skill before applying the strategy in their classrooms. This opportunity for practice additionally provided space for the participants to reflect on their current practices and challenge their previous paradigmatic beliefs. Believing in the pedagogy and their ability to design and deliver new instruction stimulated the teacher's choice to attempt its use in their classroom. This new belief prompted a choice to change the teacher's classroom practices. Once the teacher successfully engaged the new pedagogy in their classroom, positive student outcomes then validated the practice, thus leading to even more changes in beliefs and attitudes. However, I argue the absence of pedagogical substantiation would have prevented certain participants from moving to the second stage of Guskey's (2002) model of teacher

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change. Without pedagogical substantiation, it remains likely certain participants would have remained in the first PD stage.

The perceived epistemological shift described by participants revealed the level of internalization they experienced. They adopted the value of new pedagogy to the extent of voluntarily using it in their own classrooms. Not a single participant received a mandate to apply their new learning. Value recognition and student response greatly solidified the internalization process; however, the contextual factors of lesson study increased feelings of competence, relatedness, and autonomy, which combined to encourage value recognition. In the end, the current study's findings suggest lesson study may offer a robust form of PD capable of changing a teacher's epistemological paradigm.

Limitations

By its very nature, qualitative research does not promote generalizability in the same way as experimental or randomized quantitative research does; however, transfer can occur on a case-by-case basis (Firestone, 1999; Onwuegbuzie & Leech, 2007). This concept of transfer suggests qualitative interpretations may inform practice under specific conditions. For example, if a consumer of research exhibits context that parallels qualitative research, then findings may apply. To facilitate informing consumers of research regarding parallel context, Bryman (2012) asserts a thick description describing qualitative research contexts such as sample and natural setting provide background knowledge informing consumers, thus enhancing transferability judgements. This explains why the current study provided detailed descriptions of the population and their schools. Consumers of research may use this information to determine if this study's results meet their transfer criteria. Therefore, I argue principals/staff developers may transfer this study's results to their specific campuses if parallel contexts exist according to their judgement.

Future Research

Future recommendations for lesson study research include (a) public school implementation, (b) motivation related to nonvolunteering teachers, (c) managing interpersonal group dynamics, and (d) race. While the current study described a PD program using LSOA for public school mathematics teachers, the setting included volunteers who learned in university and classroom locations. University professors developed and facilitated the logistics and operationalization of the program. While this provided perceived support for the participants, the goal of lesson study rests on successful implementation in public schools. Principals need to understand how to properly establish lesson study in schools that meet logistical requirements, as well as motivational needs for teachers.

The current study consisted of subjects who volunteered to participate in learning new pedagogy. The participants entered the program with enthusiasm and maintained motivation throughout the two-year duration. Further research might consider contextual factors, within a public school setting, that contribute to motivation for teachers who do not specifically volunteer to participate in a lesson study PD. Many public schools require teachers to participate in some form of PD as a requirement of employment. Therefore, studying teacher reaction to mandated lesson study participation through the lens of SDT could provide insightful results. Of specific interest, researchers should note or examine lesson study's potential to promote movement through the regulatory styles (i.e., external, introjected, identified, and integrated) of motivation as articulated by Ryan and Deci (2008). This could add to understanding specific contextual factors that might motivate teachers who do not normally volunteer to participate in rigorous forms of PD.

The third recommendation for future research centers on addressing interpersonal group

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dynamics. Because lesson study relies heavily on collaboration, groups maintaining a healthy balance between harmony and substantive conflicts remains prominent. Unhealthy interpersonal dynamics embodies a potentially meaningful threat to teacher motivation. A dysfunctional team could reduce relatedness to the point of substantially diminishing the effectiveness of learning from a lesson study approach. Therefore, future researchers might consider how principals could manage the healthy development of teams as they progress through the four phases of group development.

As teachers, principals, and schools continually work to improve adult learning, which improves student achievement, the field of PD research might similarly work to produce information to support such efforts. Stressing the importance of lesson study implementation in public schools, motivation related to nonvolunteering teachers, and managing interpersonal group dynamics can further inform meaningful research. Results from such studies could likely enhance the knowledge and understanding of principals who provide choices and guidance when working to help their teachers improve student learning.

Due to time limitations, this study did not consider how race informed LSOA. This study was conducted with a race-neutral perspective because LSOA is new and not well established in the United States (U.S.). However, this study does offer a baseline perspective that creates space for the addition of future studies that include evaluating teacher motivation in the context of LSOA using a critical race perspective. Using critical race theory may provide further explanations of social and environmental factors that increase or decrease teacher motivation.

<div align="center">Summary</div>

This study described how teachers perceived the social and environmental factors related to LSOA that shaped motivation. Teachers perceived many of these factors as positive, thus

increasing opportunities to meet their needs of competence, relatedness, and autonomy. As teachers met these needs, they concurrently internalized the value of new learning, which became personally important to them. Once internalized, teachers employed the use of new pedagogy in their classroom according to their own volition. When participants witnessed consistent student achievement, enjoyment, and confidence, their shift in paradigm reached fruition. This eventual shift occurred as a result of high-quality learning framed in the lesson study approach.

Supporting teacher learning should consider how to authentically change a teacher's epistemological beliefs. This challenge, often ignored by PD approaches, lies at the crux of PD. If a teacher maintains an orientation connected to their original teaching paradigm, the likelihood of a faithful adoption of new teaching remains unlikely over time (Guskey, 2002; Kadroon & Inprasitha, 2013;). This explains why Gusky (2002) insisted PD often fails because facilitators do not consider teacher motivation or the teacher-change process.

Using SDT not only provided a theoretical framework, it offers practical implications for principals acting as instructional leaders. According to Ryan and Deci's (2017) self-determination continuum, a person's intrinsic-like motivation can move from lower levels, such as external regulation, to higher levels, like integrated regulation, as they internalize the value of a task. The potential for movement across the continuum is important for principals because they can enhance or facilitate contextual factors to increase a teacher's motivation to implement new learning. According to the current study, by promoting (a) emerging proficiency, (b) synergy, (c) interpersonal dynamics, and (d) volition, an instructional leader may increase the probability of moving a teacher to more productive levels of intrinsic-like motivation.

Principals who promote the contextual factors revealed in this study may increase the

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internalization process of teachers. This is of importance because, according to Roger's theory of diffusion of innovation (Rogers, 2003), only 16% of teachers will most likely embrace new learning from an innovator or early adopter perspective. By promoting the factors discussed in this research, principals may have a higher change of encouraging early majorities, late majorities, and laggards to experience success so they are more willing to accept new teaching strategies.

The results of this study provided encouraging information related to PD that emphasized contextual factors that both motivate teachers and inspire the teacher-change process. Both of these contextual factors encouraged teacher learning and authentic classroom curricular engagement of new strategies. Using STD as a framework, this study reported contextual factors influencing competence, relatedness, and autonomy, which may lead to internalized forms of motivation that supports a teacher's epistemological shift. This intrinsic-like motivation causes increased perseverance, focus, creativity, awareness, and goal congruence, which promote the healthy development of teacher learning.

In conclusion, principals or PD facilitators may strongly consider maintaining contextual factors with intentional purpose to promote and maintain teacher motivation when asking them to change their teaching paradigm. If these considerations escape the awareness of PD facilitators, the consequences could result in wasted resources, time, and static student achievement.

APPENDIX A

TEACHER REFLECTIVE PROMPTS

Prompt

 1. Describe your reasons for applying to this professional development.
 2. What challenges do you face in teaching that this professional development may help you address?
 3. Describe one significant event, theme or idea from the summer professional development.
 4. How will implementation of these ideas benefit your students?
 5. How did your professional development summer experience impact your thinking about teaching and learning?
 6. Discuss how these new ideas helped you think about and plan for this academic year.
 7. Discuss how you "get along" with the other teachers in your Lesson Study group. How does this relationship help or hurt your learning? [Written Reflection #6]
 8. Discuss the reality and complexity of your school or teaching setting.
 9. How has your professional development experience helped you grow in being able to offer a rich learning experience? [Written Reflection # 2]
10. Describe the role you assumed during your work in the Lesson Study group. For example, did you assume the role of a leader, mediator, math specialist, etc. Explain the process of how members in your group developed certain roles.
11. How did the professional development experience expand your depth of understanding of the concepts related to your area of teaching? How did this expanded depth of knowledge help you in your teaching? [Written Reflection # 3]
12. How has your deeper understanding of this content increased your awareness of the interconnection to other conceptual areas and topics?
13. Describe the level of belief you had in your Lesson Study group's ability to create lessons that would positively influence student outcomes.
14. Describe the method that you use to communicate and collaborate with your fellow professional development teachers between sessions?
15. How do (or could) these collaborations enrich your practice?
16. How did the relationships with the other teachers in your Lesson Study group develop or change over time?
17. Provide at least one example of how your growth as a teacher affected student achievement in your classroom.
18. How have the instructional strategies you learned in this professional development increase meaningful learning by all students in your classroom?
19. Describe the "pros" and "cons" of working with your Lesson Study group and explain how each ultimately affected what you do in the classroom. [Written Reflection # 7]
20. Describe how your professional development experiences have fostered your growth as a teacher resulting in an expanded role in your school or district setting. You might consider areas such as: departmental and school leadership responsibilities; collaboration with, mentoring, or coaching fellow teachers; participation in professional organizations (including presentations at the local, regional, or state level); school or district committee participation or leadership; leadership in extracurricular, academic programs; or other leadership examples.

Note: Bracketed numbers relate to written reflections.

APPENDIX B

STUDY THEMES AND SUBTHEMES

Category/Theme/Subtheme	Definition
Competence	
I Emerging Proficiency	• trusting new pedagogy and understanding how to enact it in their unique classroom
1. Collective Validation	• increased confidence due to approval or admiration from other teachers
2. Pedagogical Substantiation	• teacher personally observes evidence supporting pedagogical effectiveness
3. Acute Feedback	• receiving focused and specific feedback from knowledgeable peers
4. Pedagogical Affirmation	• meeting desire to learn *what* and *how* to teach mathematics
II Apprehension	• feelings leading to reductions in confidence or success when enacting some portion of lesson study cycle
5. Lack of Communication	• reduced information exchange leading to perceived decline in group's ability to achieve goals
6. Vulnerability	• fear that peers would perceive one's teaching as inadequate
Relatedness	
III Synergy	• collaboration creating ideas greater than individual contributions
7. Meaning Negotiation	• working with others to understand how to operationalize new pedagogy
8. Collective Solidarity	• learning curve less daunting when all are experiencing similar challenges
IV Minor Barriers	• minimal obstructions temporarily impeding task completion
9. Collective Rejection	• emotional distress when group devalues an idea
10. Time Consuming	• implementing lesson study with fidelity requires time commitment
11. Limited Experience	• participants wanted to experience more roles and live lessons
12. Overwhelming	• too many suggestions from group make it difficult to narrow focus
V Interpersonal Dynamics	• interaction quality among members when performing collaborative functions
13. Positive Interpersonal Dynamics	• harmonious interactions characterized by a feeling of connectedness
14. Contentious Interpersonal Dynamics	• inharmonious interactions characterized by diminished feelings of connectedness
15. Meaningful Collaboration	• positive interpersonal dynamics promote effective learning
16. Conflict Apprehension	• fear of conflict leading to less learning
Autonomy	
VI Volition	• making decisions based on one's choice or will
17. Growth Preference	• ability of a participant to self-select their level of growth based on available choices
18. Voluntary Participation	• participating in lesson study based on choice and wanting to learn
19. Ownership	• having choice when determining lessons, activities, roles, data collection methods etc. increased the worth and value of their learning thus making it more personally meaningful
Motivation	
VII Internalization	• process of acknowledging value and worth of behavior thus leading to autonomous-like motivation
20. Value Recognition	• teachers recognized the value of new paradigm and used in their classroom
21. Student Response	• teacher's willingness to implement new pedagogy based on favorable or unfavorable student response
22. Epistemological Shift	• teacher changes teaching paradigm

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