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The Effects of a Mathematics Instructional Leadership Program on
Shared Leadership and Continuous Improvement

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Abstract

While research suggests a connection between shared leadership and continuous improvement in the educational context, how those two are connected is largely unknown. The Mathematics Leadership Corps (MLC), a math instructional leadership program, aims to develop a culture of shared leadership and continuous improvement within districts through peer coaching. This paper describes the outcomes of a three-year implementation of the program in an urban K-12 school district in a Western state. Analyses of longitudinal survey and focus group data indicate that teachers, math coaches, and administrators observe some growth of the culture of shared leadership and continuous improvement in their district. They also perceive barriers to collaboration due to variations in understanding of the program values, which suggests that an intervention brought in by external organizations may have limited influence. This paper attempts to bring attention to the need for internal solutions for addressing math educational problems.

Keywords: math instructional leadership, peer coaching, shared leadership, continuous improvement, professional development

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Districts and schools are complex organizations made up of factors and relationships that connect people through formal and informal networks (Morrison, 2002). They must meet federal, state, and local mandates; work together within the schools and community; and employ a variety of methods to improve various aspects of the organization. Therefore, issues in schools and districts are also complex; they are multi-dimensional, involve multiple stakeholders, causes, symptoms, and solutions, and constantly evolve (Watkins & Wilbur, 2015). It is difficult to formulate a single solution because the nature of the problem depends on the unique context of the school setting and personnel involved. For effective implementation of a solution, school districts must tailor it to the context and provide adequate support.

Math education is a complex issue faced by U.S. school districts today. The United States ranked 27th out of 34 Organization for Economic Co-operation and Development (OECD) countries in 2012 on the international test of mathematics⁵ for 15-year-olds (Organisation for Economic Co-operation and Development, 2013). Addressing this problem requires all those invested in math education – teachers, administration, students, parents, and the community – to work together to evaluate the causes and determine potential solutions.

Even when organizations recognize that their problems are complex, they often try to solve those problems with quick, one-shot solutions. For example, schools may hire external consultants for a professional development day or may purchase a new technology program to support student learning. Senge (2006) warns that these types of interventions often do not address the underlying causes, but rather focus on the obvious symptoms. Such solutions may provide an immediate fix for a limited time, but they are not sustainable and thus fail to last in

⁵ The Programme for International Student Assessment (PISA)

the long-term (Senge, 2006). The issue with reliance on external parties is that they bring knowledge and skills that cannot adequately address context-specific issues. Thus, individuals within the organization must actively take part in identifying the root cause of the problem and developing solutions (Helsing, Howell, Kegan, & Lahey, 2008). Moreover, they need to understand their own internal belief systems and challenge each other's ideas while working together (Senge, 2006).

Addressing complex problems in education organizations, such as a school district, starts with leaders who have continuous improvement mindsets to encourage and support risk-taking and learning through failure (Morgan, 2006). As Senge (2006) notes:

In a learning organization, leaders are designers, stewards, and teachers. They are responsible for *building organizations* where people continually expand their capabilities to understand complexity, clarify vision, and improve shared mental models—that is, they are responsible for learning. (p. 340)

In essence, the solution is an internal culture and structure in which all members of the organization value and strive for continuous improvement. A single leader cannot create such culture and structure. Internal change must involve multiple groups of stakeholders working together to achieve shared goals with a common vision. Such shared leadership brings out individual strengths and expertise in a synergetic manner while reducing the burden for a single leader in the organization (Kocolowski, 2010). The purpose of this paper is to describe the development of shared leadership and continuous improvement culture within a school district as a result of implementation of a mathematics instructional leadership program.

Literature Review

Continuous Improvement

Continuous improvement is the systematic process of improving instruction and student learning by using data to continually evaluate the organization's goals, actions, progress, and outcomes (Hawley & Sykes, 2007; O'Connor & Freeman, 2012). In essence, it is the act of using data to make educational decisions at the district, school, and classroom levels (Means, Padilla, & Gallagher, 2010). The underlying assumption for continuous improvement is that responsiveness to various types of student learning data helps schools and districts to improve (Marsh, McCombs, & Martorell, 2010). Four features are important in this process. First, the purpose of continuous improvement efforts is to achieve clear, shared goals around improved instruction and student learning (Devlin, 2005; Stosich, 2014). This coincides with the purpose of practicing shared leadership. Second, members of the organization engage in ongoing, intentional, and collaborative efforts for continuous improvement (Anderson & Kumari, 2009; Devlin, 2005; Hawley & Sykes, 2007). Third, these efforts are embedded in the daily work of the individual members in the organization (Park, Hironaka, Carver, & Nordstrum, 2013). Fourth, and most importantly, it is essential to develop and systematically use data collection and analysis methods (Devlin, 2005; Stosich, 2014).

Hawley and Sykes (2007) describe a continuous improvement model that includes four phases making up a cycle. In the first phase, school members set school-wide priority goals for student learning and develop a consensus on how to assess the achievement of those goals. Second, they continuously and collectively evaluate student learning data from both formal and informal assessments. The third phase is collaborative problem-solving based on evidence. In this phase, members of the school work together to determine the nature of the problem, assess internal challenges for improvement, and identify evidence-based practices to address the problem (Hawley & Sykes, 2007). The last phase is implementing the best-evidence practice identified in the previous phase. During this process, the school uses student learning data to

monitor the progress of solving the identified problem (Hawley & Sykes, 2007). This process illustrates how a school district can address complex math education problems: its members need to collectively know how to set measurable goals, collect and analyze relevant data, and collaboratively identify and implement solutions.

Continuous Improvement and Shared Leadership

Research suggests that continuous improvement in schools requires the distribution of clearly defined leadership roles - such as instructional, administrative, and student support - and collaboration between them (Anderson & Kumari, 2009). Collaboration allows educators with these different roles to develop a shared, deep understanding of the purpose of continuous improvement efforts (Hawley & Sykes, 2007). This study is based on the assumption that shared leadership is necessary for continuous improvement of schools and districts.

Shared leadership perspective. Educational research that has shifted its focus from a single leader to multiple leaders within schools often uses related terms including shared leadership, distributed leadership, collective leadership, and collaborative leadership. The term shared leadership in this paper encompasses all of these different types of leadership. Shared leadership is a process in which two or more members of a group mutually influence one another and share responsibilities to achieve common goals (Bergman, Rentsch, Small, Davenport, & Bergman, 2012; Kocolowski, 2010). Particularly in schools and districts, it refers to the active formation, facilitation, and accumulation of leadership practices by various members, including teachers and administrators, to achieve shared goals for student achievement (Gigante & Firestone, 2007; Harris, 2008). Leadership practices in this sense include: actively and cooperatively using all members' expertise, ideas, and efforts (Krovetz & Arrianza, 2006); setting directions, developing people and organization, and managing the instructional program (Leithwood, Patten, & Jantzi, 2010); and performing instructional leadership (Camburn, Rowan,

& Taylor, 2003). Some of these practices are better performed when distributed among multiple members within the school system rather than by a single leader; some practices are performed by formal leaders, such as site administrators, while others are performed by informal leaders such as teachers (Leithwood et al., 2007).

Spillane, Healey, and Parise (2009) state that such leadership practices are products of interactions among leaders and followers in the social context of the school. Leadership is not about skills, knowledge, or formal structures and functions (Spillane & Diamond, 2007). Rather, it is a system of practice in which individuals interact in reciprocal interdependence (Spillane, 2005). Specific patterns of leadership distribution exist: collaborated distribution in which leaders execute the same leadership practice at the same time and place; collective distribution in which leaders work separately but interdependently; and coordinated distribution in which leaders work in sequence (Spillane, 2006). These patterns imply that not everyone is a leader and that leaders and followers make different contributions in each situation (Spillane & Diamond, 2007). While shared leadership involves individuals without formal leadership titles, site administrators still perform unique leadership practices (Spillane & Diamond, 2007). They play an important role in realizing true shared leadership in that their attitudes and behaviors, such as willingness to relinquish control, can be influential in the distribution of leadership (Wright, 2008).

Pathways to continuous improvement. Leadership at different levels contributes to continuous improvement. District-level leadership understands, supports, and organizes the continuous improvement process of goal setting, needs analysis, progress evaluation, and decision-making (O'Connor & Freeman, 2012). School-level leaders facilitate change toward improvement by encouraging and supporting teachers' learning and commitment (Hawley & Sykes, 2007). The capacity for continuous improvement also increases when teachers participate

in instructional decision-making, collaborate on improvement strategies, have shared understanding of effective practice, engage in productive debates, and take responsibility to follow through with decisions (Stosich, 2014). For this collaborative approach to problem solving to be successful, a school culture of trust, mutual respect, experimentation, constructive criticism, and shared belief that all students can achieve specific learning targets must be in place (Hawley & Sykes, 2006; Means et al., 2010; O'Connor & Freeman, 2012; Stosich, 2014). Also essential are structures that provide platforms for school members to identify and solve problems together, such as regular meetings involving different members (Hawley & Sykes, 2007).

While the literature links elements of shared leadership with continuous improvement, documentation of how shared leadership practices enable educators to practice continuous improvement is lacking. More fundamentally, there is limited understanding of how shared leadership develops in school districts. Previous studies have centered either on the work of the site administrator or on teacher leadership rather than how individuals with unique roles and responsibilities work interdependently as a group. This study examined how an intervention focused on math peer coaching influenced shared leadership and continuous improvement in a K-12 district.

Intervention

The Mathematics Leadership Corps (MLC) is a partnership-based math instructional leadership program. It implements a peer coaching system within a school district to develop a culture of continuous improvement. MLC defines continuous improvement as frequent and focused review of instructional practice through student learning data analysis. The specific instructional practice focuses on students' mathematical thinking, problem solving, and self-regulated learning. The program develops instructional leadership among administrators,

coaches, and teachers to create a culture of continuous improvement through shared responsibilities and professional accountability.

MLC teachers participate in job-embedded peer coaching to improve data-driven, student-focused math instruction. Teacher-coach pairs meet weekly to analyze student data and work samples, examine research recommendations and best practices, set goals for student learning, refine chosen instructional practices, and adjust plans based on data. Teachers also meet one to two times per month as a learning community to participate in training about instructional practices, analyze student trend data, create common formative assessments and plans, and engage in collaborative inquiry. During school-based Instructional Rounds, coaches and teachers observe other teachers using specific content and pedagogy practices in the classroom to inform decisions about their own practice. Through these activities, coaches and teachers continuously refine and enhance their vision of math instruction.

Coaches meet monthly to improve their coaching practice, analyze teacher and student data, and reflect on their current coaching using research recommendations for teaching and learning mathematics. During the first two years of MLC implementation, coaching teams meet regularly with their MLC support person from external partnering organizations.

Administrators and coaches meet regularly to discuss student trend data, problem solve, and determine next steps to support the coaching system. Administrators participate in trainings with their external MLC support persons, focusing on student data collection and analysis.

Methods

Site

An urban, ethnically diverse K-12 school district in California implemented MLC beginning in the 2013-14 academic year. At the time, over 6,500 students attended 5 elementary schools, 1 middle school, and 1 high school within the district. In the first year of MLC

implementation, two elementary schools and the middle and high schools participated. This paper focuses on this first cohort of schools.

Design

This mixed-methods longitudinal study utilized surveys and focus group interviews at multiple points in time. MLC participants engaged in two years of intensive coaching and received an additional year of support. The researchers asked all teachers and administrators in the participating schools to complete a survey prior to MLC implementation (2013-14) and at the end of each academic year. In the middle of the second (2014-15) and third (2015-16) years, the researchers conducted focus group interviews with teachers, coaches, and administrators. This paper utilizes survey data from baseline and end of the third year and focus group data from the middle of the third year.

Sample

The survey analysis sample included 27 teachers and administrators who completed the survey at both baseline and end of the third year. These respondents included eight (30%) MLC participating teachers, five (19%) coaches, five (19%) administrators, and nine (33%) non-participating teachers. Table 1 shows the demographic information of the survey sample.

Table 1. Demographic information of the survey sample (N=27)

Context	Freq.	%	Demographics	Freq.	%
School			Gender		
Elementary A	8	30%	Male	7	26%
Elementary B	7	26%	Female	20	74%
Middle school	7	26%	Race/ethnicity		
High School	5	19%	White	21	78%
MLC participation			Asian	4	15%
Participating teacher	8	30%	Other	2	8%
Coach	5	19%			
Administrator	5	19%			
Non-participant	9	33%			
Teachers (n=22)	Mean (SD)	Min-Max	Administrators (n=5)	Mean (SD)	Min-Max
Years of teaching			Years of administration		
In current school	12.25 (7.94)	0-29	In current school	2.80 (1.79)	0-4
Overall	17.05 (9.01)	0-29	Overall	7.00 (2.58)	4-10

The focus group sample included nine MLC participating teachers, twelve coaches, and seven administrators from all schools in the district. This sample included teachers in schools that participated in MLC one year later in 2014-15. The researchers used quota sampling method to recruit interviewees. Since four schools joined MLC in the initial year and two joined the next year, the sample included more interviewees from the initial cohort of schools than from the schools that joined later. The researchers conducted separate interviews with coaches who started coaching in 2013-14 and those who started coaching in 2014-15. By definition, all coaches in the first group are from the initial cohort of schools. Table 2 shows the group composition.

Table 2. Focus group participants (N=28)

Group	From initial cohort of schools ^a	From later schools ^b	Total	Number of males
MLC participating teachers	7	2	9	2
Coaches, 2014-15 cohort	2	4	6	0
Coaches, 2013-14 cohort	6	0	6	2
Administrators	5	2	7	0
Total	20	8	28	4

^a Two elementary schools, one middle school, and one high school that started implementing MLC in 2013-14.

^b Two elementary schools that started implementing MLC in 2014-15.

Measures

Teacher/administrator questionnaire. This study used a questionnaire developed for evaluating MLC. The questionnaire contained 13 items that measured respondents' perception of shared leadership in their schools and 13 items that measured perception of continuous improvement on a five-point scale from "not true" to "definitely true." Shared leadership encompassed (1) the presence of a shared vision for collaboration and (2) collaboration between administrators and coaches. Examples of shared leadership items are: "Teachers, counselors, and administrators use open-ended questions to solve problems;" "Teacher leadership is shared according to expertise rather than seniority." The continuous improvement subscale was about

reflective practice based on student evidence, research, and peer observation and feedback.

Examples of continuous improvement items are: “Teachers change their practice as a result of reflecting on student evidence, results, and actions;” “Staff recognize the need for change to improve student outcomes in math.” Cronbach’s alpha for the subscales ranged from .92 to .96.

Focus group interview protocol. The researchers designed focus group interview questions to explore the experiences and perceptions of participating teachers, coaches, and administrators regarding shared leadership and continuous improvement during MLC implementation. More specifically, questions focused on the effects of MLC on the collaboration between administrators and coaches as well as collaboration among teachers. Other questions regarding MLC’s influence on teacher instruction and student learning are not the focus of this paper.

Procedures

The Institutional Review Board at Loyola Marymount University approved the study procedures. At each data collection time point, teachers and administrators received an email invitation to fill out the questionnaire online. They received up to two weekly reminders to complete the questionnaire. A project coordinator communicated with the district administrator to schedule focus group interview times and invited MLC participating teachers, coaches, and administrators to take part in the interview. Two of the researchers facilitated the focus groups with a research assistant. Each interview lasted approximately 1 to 1.5 hours. The researchers used professional transcription services to transcribe the recordings and offered to send the transcripts to interviewees for review upon request. A few interviewees requested their transcript and checked for accuracy.

Analysis

The researchers created composite scores for shared leadership and continuous improvement by computing the means of all non-missing items within the subscales. Quantitative analysis methods included descriptive statistics, bivariate correlation, and multiple linear regression. Since MLC aimed to influence the culture of the schools rather than just the MLC participants' beliefs and attitudes, analyses included all survey respondents regardless of their role in the MLC implementation.

Two of the researchers and two research assistants used consensual qualitative research (CQR) method (Hill et al., 2005; Hill, Thompson, & Williams, 1997) to analyze the focus group data. Using the transcript of the interview with new coaches (2014-15 cohort), the analysis team developed domains to group blocks of data into broad themes, composed abstracts (core ideas) for each block of data, and developed categories within domains. During this process, the team met four times to reach consensus on the domains and categories and created a codebook. Using the codebook, three of the team members then coded the remaining transcripts, met again to discuss discrepancies, and reassigned codes as necessary.

Results

Table 3 presents the descriptive and bivariate correlation analysis results of shared leadership and continuous improvement survey data at baseline and at the end of the third year. Survey respondents' perception of shared leadership in their schools significantly correlated with the perception of continuous improvement in their schools at each time point. Paired samples t-test results indicated that the increases in shared leadership and in continuous improvement from baseline to end of the third year were both statistically significant, $t(26) = -5.135, p < .01$ and $t(26) = -3.960, p < .01$, respectively. Due to small sample size, the researchers did not attempt to predict any outcomes. However, further analysis using multiple linear regression revealed that respondents' perception of shared leadership at the end of the third year is associated with their

perception of continuous improvement at the end of the third year, controlling for baseline perception of continuous improvement, $F(7, 19) = 8.173$, $p < .01$, $R^2 = .751$.

Table 3. Perception of shared leadership and continuous improvement (N=27)

Variable	Time	Mean (SD)	Shared leadership		Continuous improvement	
			Baseline	End of year 3	Baseline	End of year 3
Shared leadership	Baseline	3.24 (0.95)	1	.422 *	.844 *	.461 *
	End of year 3	4.11 (0.60)		1	.403 *	.657 *
Continuous improvement	Baseline	3.20 (0.95)			1	.539 *
	End of year 3	3.84 (0.73)				1

* $p < .05$

Focus group data analysis produced 11 domains; six of those domains pertained to different actors of collaboration. Of those, the domains that all groups discussed were collaboration between administrators and MLC participating teachers, and site-wide collaboration. In addition to the collaboration types, the researchers identified domains of: collaboration before MLC implementation, barriers to current collaboration, conditions for effective present and future collaboration, expectations for future collaboration, and teacher leadership. Of these domains, the most frequently discussed themes were barriers to collaboration and conditions for effective collaboration. Table 4 shows the domains, categories, and the number of cases (blocks of data) in each category.

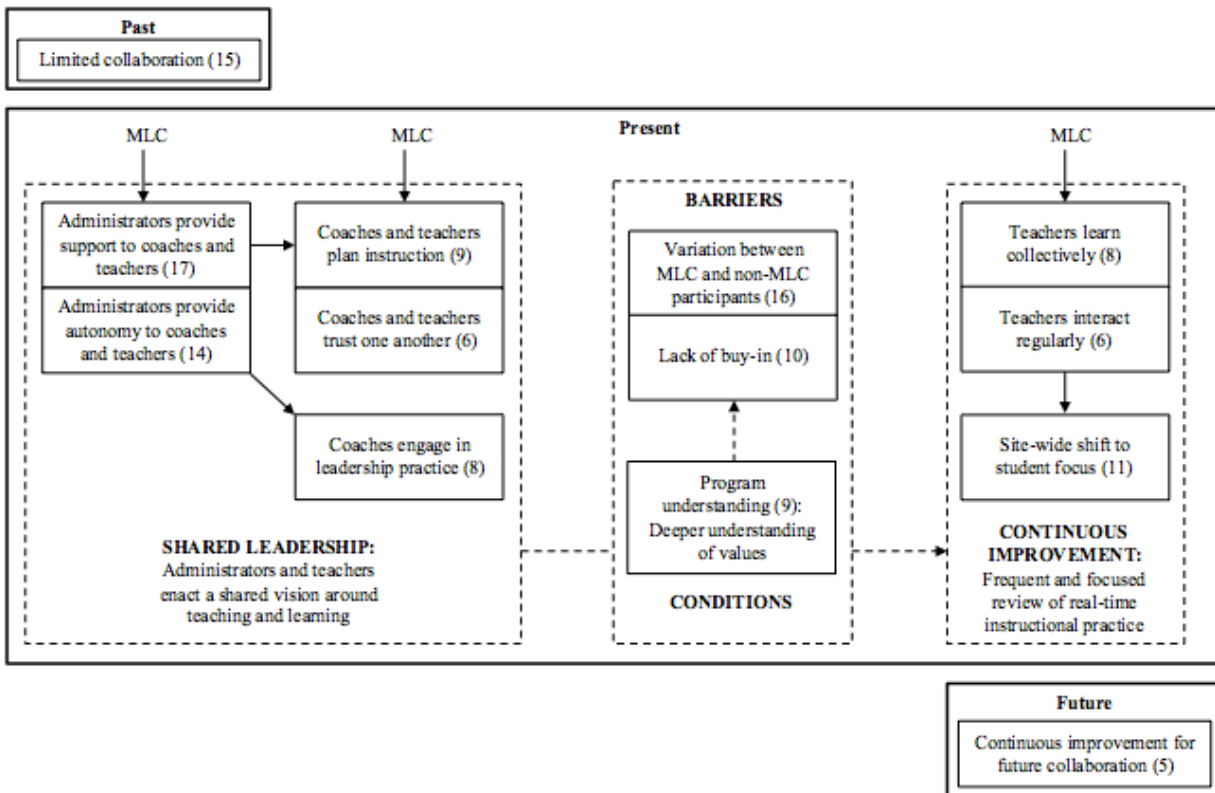
Table 4. Collaboration domains and categories derived from focus groups

Domains and categories	Number of cases	Domains and categories	Number of cases
Collaboration between administrators and MLC participants		Pre-MLC collaboration	
Administrators provide support	17	Limited collaboration	15
Administrators provide autonomy	14	Lack of efficiency	2
Administrators check in consistently	4	Barriers to collaboration	
Administrators need to communicate clearly	4	Variation between groups	16
Administrators provide support	3	Lack of buy-in	10
Administrators create a safe environment	3	Variation within groups	7
Administrators create an unsafe environment	3	Program clarity	6
Collaboration between coaches and MLC participants		Time Constraints	5
Planning	9	Program limitations	3
Trust	6	Conditions for effective collaboration	
Distrust	2	Financial support	10
Collaboration among MLC participants		Maintaining current roles	9
Collective learning	8	Program understanding	9
Regular interaction	6	Separate coach role	7
Collaboration between coaches and non-participants		Adequate time	3
Pre-existing relationship	3	Expectations for future collaboration	
Informal collaboration	2	Continuous improvement	5
Site-wide collaboration		Positive outlook	3
Student-focus	11	Share knowledge	3
Increased collaboration	5	Teacher leadership	
Common structure	5	Leadership practice	8
Same subject	4	Leadership pressure	3
Informal site-wide collaboration	2		
Underdeveloped culture of collaboration	2		
Site-to-site collaboration			
Program Purpose	2		

Hill et al. (1997; 2005) suggest labeling categories based on their occurrence across interviews, such as “general” if the category is present in all interviews and “typical” if the category exists in more than half of the interviews. However, the researchers did not assign those labels due to the small number of interviews. Instead, the researchers identified possible connections between categories with the largest number of occurrences within each domain. This paper refers to focus group participants as “interviewees” to distinguish them from “MLC

participants,” which include both MLC participating teachers and coaches. As Figure 1 shows, the interaction between administrators and MLC participants may influence shared leadership, while collaboration among MLC participants may relate to a shift in site-wide collaboration to student focus, which is part of continuous improvement. Barriers and conditions exist that influence student-focused collaboration. Interviewees also discussed past (before MLC implementation) and future (after completion of MLC implementation) collaborations. The diagram incorporates points of MLC intervention.

Figure 1. Possible relationships among categories derived from focus groups



Shared Leadership

MLC defines shared leadership as administrators and peer coaches enacting a shared vision around teaching and learning through collaboration. In the beginning stages in this particular district, MLC was a focused intervention to establish a peer math instructional

coaching system. In the third year of implementation, MLC added leadership group meetings to facilitate collaboration between administrators, coaches, and math department heads.

Consequently, administrators and the two groups of coaches recognize increased *support* by administrators for MLC participants. Support is in the form of valuing the MLC participants' opinions and providing feedback on their work. For instance, an administrator stated: "Now in year 3, we've been involved in the leadership aspect of supporting the coaches more; where the coaches are seen on daily basis for support on their coaching, and being leaders within their department, and being able to lead but co-collaborate with their teachers that they're coaching." The researchers identified this category only once in the MLC participating teacher interview, suggesting that administrators' support for teachers is not as direct or observable as their support for the coaches.

Another way that administrators interact with MLC participants is providing *autonomy*, a theme that mostly emerged from the interview with the new coaches who started coaching in the 2014-15 academic year. Administrators provide autonomy to MLC participants by allowing them to make autonomous decisions regarding coaching and instruction and by communicating to provide assistance but not micromanaging. These types of interactions allow coaches and MLC participating teachers to independently engage in collaborative actions, such as co-planning lessons, identifying personal goals for instruction, and monitoring progress. This process is also based on the *trust* between coaches and their participating teachers, as exemplified by a new coach's comment: "Having an external, a person outside of the classroom in-house – somebody told me the other day, we trust you, we know you, we see you in the lounge – versus an outside person, is very, very, very conducive to moving forward and improving."

Administrators and coaches also discussed instances of teacher *leadership practice* defined as teachers taking on responsibilities beyond their regular coaching or teaching duties.

Interviewees stated that coaches and various teams within the schools make decisions about issues such as the focus of Professional Learning Community meetings and the math department. Other examples include designing and facilitating professional development seminars and hosting parent information sessions regarding math instruction. However, new coaches also reflected that they felt pressured to take on ambiguous leadership roles at times. This relates to a less frequently observed category not diagrammed: administrators need to communicate more clearly about roles and responsibilities within MLC.

Taken together, focus group data support the survey results indicating increased collaboration between administrators and coaches. The data further suggest that increased support and autonomy from administrators may positively influence collaboration among teachers and the leadership practices of coaches by allowing them to make decisions. One coach's statement illustrates this point:

“I feel like our principal sort of looks to us. We're involved in this process as sort of being the experts. We've been so well-trained... She's educated herself on what we're doing and trusts us to make appropriate decisions and keep her informed of what we're doing so that she can speak about it to parents, mostly. We are treated as having very valuable experience, and we'll be very thoughtful about what decision we're making. We make decisions as a team. It's not just one isolated person deciding for us all. We have good conversations about it. She just allows us to do that.”

Continuous Improvement

MLC defines continuous improvement as frequent and focused review of instructional practice through peer coaching and data-driven math instruction. In addition to the coaching system, MLC provided structured opportunities for collaboration among its participants, such as professional development seminars and inquiry meetings. Through these regular interactions,

MLC participants engaged in *collective learning*: they learned new data-driven math instructional methods and values of reflective practice together, eventually arriving at a common language and method of student data analysis. A similar category that emerged as part of site-wide collaboration is *common structure*, which refers to the presence of common terminology, values, and practice that facilitate collaboration. At the time of the focus group interviews, all of the non-participating teachers in the elementary schools were in a coaching program that the district designed and implemented to match what MLC participants were practicing to eventually unify math instruction in the district. In the middle and high schools, almost all math teachers were MLC participants. Interviewees expressed that having the common structure helps them to collaborate with more people, as described by a participating teacher:

“When we go observe [another teacher’s class], it’s not as scary because they’re doing the same exact thing that they would be doing in third [grade], just a little bit of a different problem type or numbers are a little bit higher or more difficult. It does allow for a lot more conversation and for us to understand what they’re doing in different grade levels because they’re all basically starting in the same way when they start a new problem type.”

In turn, site-wide collaboration, involving administrators, coaches, MLC participating teachers, and non-participating teachers across grade levels, now has a new *focus on students* and how they learn. As administrators view their schools as a whole beyond just the math program, they see the difference between the math faculty and other subject departments. Since math teachers’ collaboration is more focused on using student data to inform practice, one administrator is trying to expand the influence to the entire site:

“And that’s a conversation that I’m having at the entire site, but because math had already made that switch now 2 years ago, they’re in a place where that’s where they focus on.

They've been focused on student evidence and outcomes, you know, more than any other department. They're not focused on 'so what are we going to do next,' it's more like 'what do we need to do based on what we see from the children.'”

On the other hand, interviewees described collaboration before MLC implementation as *limited* to small groups about curriculum or sequence of instruction. This category emerged from all four focus groups. One coach stated, “I’d say the collaboration we had in the past primarily for us was grade level. Whoever’s teaching the same class you are, and it was more planning; what am I going to teach next?” MLC’s focus on reflective practice through coaching and group learning opportunities appears to have influenced the way teachers view collaboration. While the survey data show an increase in teachers’ reflective practice, focus group results add that teachers have begun to engage in site-wide collaboration to assess trends in student learning as a group.

Connection Between Shared Leadership and Continuous Improvement

While the survey data show a simple correlation between shared leadership and continuous improvement, the focus group data provide insight into the possible underlying mechanism for the relationship. Discussion of the present collaboration among different actors included difficulties in collaborating, which naturally led to the identification of current barriers. The most significant barrier noted by all groups is *variation* between MLC participants and non-participants in training and knowledge of MLC values of reflective practice. This relates to *collective learning* and the resulting *common structure* that is limited when not all teachers within the school learn the same values and instructional methods. The variation exists not just between MLC participants and non-participants. All groups stated that collaboration is difficult when a teacher, regardless of their participation in MLC, has not bought into the MLC values. Interviewees also noted conditions for collaboration that closely align with the barriers. For

instance, coaches stated that administrators, MLC participants, and non-participants all need to have a deeper *understanding* of MLC values and instructional methods, which relates to the barriers of *variation between and within groups*, *lack of buy-in*, and *program clarity*. It seems that these issues existed because MLC was an intervention that was external to the district, and therefore administrators initially did not have clear understanding of MLC values.

With the outside intervention coming to an end, interviewees discussed their expectations for collaboration in the near future. The researchers observed this domain most frequently in the interview with the newer coaches who started coaching in 2014-15. The main category that emerged was *continuous improvement*, which refers to the need for participant reflection and adaptation of the MLC model based on site-specific needs. For future collaboration, all groups stated that MLC participants and administrators need to *maintain current roles* and responsibilities, such as job-embedded one-on-one peer coaching.

Discussion

Summary of Results

After implementation of MLC for three years, teachers and administrators in the initial cohort of schools reported observing more shared leadership and continuous improvement practices which correlate positively. Focus group data provided a more detailed description of the increase in and the relationship between shared leadership and continuous improvement. Through participation in MLC, administrators learned to provide autonomy to coaches; coaches were able to work closely with their participating teachers as well as make team-based decisions about math instruction. Shared leadership in this particular district occurred primarily between administrators and math coaches. The coaching and group learning activities focusing on data-driven, student-focused math instruction helped create a common structure, including language and student data analysis methods, for site-wide collaboration. As a result, study participants

reported that collaboration is more student-focused to drive their instruction based on student learning data. This is the foundation for continuous improvement (Hawley & Sykes, 2007).

Continuous improvement mindset is not only evident in current collaboration around instruction, but also present in some coaches who want to continue the core elements of MLC by adapting it to fit the needs of their sites.

MLC seems to have positively influenced the district in developing shared leadership and continuous improvement despite some unintended consequences. For instance, coaches willingly took or created opportunities to perform leadership practices that were outside of their typical coaching or teaching roles, such as leading a professional development session or an information session with parents. Although outside the coaches' typical responsibilities, the coach may take these actions to support teachers' implementation of data-driven, student-focused instruction. These leadership practices complement modeling, working with teachers to achieve their teaching goals aligned with the site vision, and participating in peer coaching and reflective practice. On the other hand, focus group interviewees recognized barriers to collaboration that stem from variations in understanding of MLC values. The following section discusses conditions for developing shared leadership within a school district, and what is necessary for shared leadership to lead to continuous improvement.

Conditions for Shared Leadership

This study's finding that administrators' provision of support and autonomy helps coaches share leadership is consistent with the literature. In a meta-analysis of studies on shared leadership, Tian, Risku, and Collin (2016) identified support from formal leaders as one of four factors that contribute to shared leadership. Other researchers have also identified site administrator's support as essential for shared leadership because administrators can maximize leadership potential of individuals, create structural and cultural conditions for shared leadership,

and provide opportunities for frequent interactions among teachers (Gigante & Firestone, 2007; Harris, 2008; Printy & Marks, 2006).

Tian et al. (2016) identified a climate of trust as another element associated with shared leadership, as did Louis, Dretzke, and Wahlstrom (2010). In this study's focus group data, the theme of trust emerged in two different domains as a vehicle of collaboration: between coaches and participating teachers, and between administrators and MLC participants. In collaborations involving administrators specifically, administrators and coaches reported that the administrators created an environment that is non-evaluative and risk-free, while teachers expressed that at times they felt pressured to participate in MLC and being evaluated based on the participation. Interviewees expressed the need for clear communication with staff, which is important for cohesion and unity characteristic of effective shared leadership (Bush & Glover, 2012). One limitation of shared leadership is that when implemented top-down, it can become delegation of work without integrating teachers' perspectives or concerns (Wright, 2008). On the other hand, it is also possible that shared leadership can mitigate the potential negative effects of low levels of trust (Wahlstrom & Louis, 2008).

To date, research on shared leadership has not focused on how to actively develop shared leadership within school districts. MLC also started as a professional development program focused on peer coaching to promote reflective practice using student data. The introduction of administrator training on student data collection and analysis along with regular meetings between administrators and all coaches at the district level in the third year of implementation seems to have changed the way administrators interact with coaches and teachers. As a result, some of the coaches broadened their influence, for example, by planning professional development activities for the entire faculty, not just the teachers they coached. Coaches also

reported making team-based decisions regarding math instruction. This suggests that intervening at the administration level may help start the process of developing shared leadership.

This study also revealed that shared leadership may influence continuous improvement culture through multiple steps. It facilitates collective learning through peer coaching and collaborations resulting in a common language and method of student learning data analysis. In turn, formal and informal collaborations become more student-focused which is the basis for continuous improvement. However, barriers, such as different levels of knowledge and training in reflective practice as well as lack of buy-in, hinder effective collaboration. Removing these barriers may show a clearer link between shared leadership and continuous improvement. In other words, leadership may be able to facilitate collective learning more effectively if they can address the differences in learning, beliefs, and understanding.

A possible way of addressing these barriers is to incorporate systems thinking (Senge, 2006) into the intervention. According to Senge (2006), systems thinking is a framework to understand relationships and patterns; it can bring together individuals' learning and perspectives with group learning and a shared vision to influence organizational change in complex situations. District leadership with systems thinking can take the identified needs into account when creating a vision and designing and implementing a solution for math education so that the intervention reaches all levels of the organization including different roles and infrastructure. This would ensure that teachers with their own teaching and learning goals work collaboratively with a common vision.

The common barriers of collaboration identified in the focus group data are interrelated. Research indicates that teacher buy-in is crucial for continuous improvement efforts as teachers are at the forefront of classroom implementation (Margolis & Nagel, 2006). One way to encourage buy-in from teachers is to co-develop and communicate a clear vision that addresses

student learning (Printy & Marks, 2006). This is in line with research suggesting that all stakeholders in the continuous improvement efforts need to be engaged and communicate effectively to develop a collective vision (Park et al., 2013). In other words, all educators in the school district, including administrators and teachers, need to have a sense of shared responsibility for student learning (Roehrig, Duggar, Moats, Glover, & Mincey, 2008). This study's focus group data suggest that teachers received mixed messages from administration about MLC and its values of reflective practice indicating that site administrators themselves did not have clear understanding of their role in the program from the beginning. This is notable given site administrators' major role in guiding the school's vision for professional learning (Leithwood et al., 2010). Assisting administrators to collaboratively create their own instructional leadership program with teachers using the systems thinking approach may minimize the barrier between shared leadership and continuous improvement. Coaches in the studied district are already recognizing the need to adapt MLC to their context to continue building continuous improvement culture. Investigation of how the adapted program differently influences shared leadership and continuous improvement may provide additional insights on how to develop internal capacity for solving complex math education problems.

Limitations and Directions for Future Research

This study contributes to the education literature by describing how an intervention for math instructional leadership may develop shared leadership within a school district. It also identified the conditions necessary for shared leadership to ultimately influence district-wide culture of continuous improvement. A main limitation of this study is the small, non-random sample which limits quantitative data analysis methods and the generalizability of the findings to other districts. Measurements of shared leadership and continuous improvement were at the school level only, which limit the understanding of how individuals' shared leadership and

continuous improvement practices develop. Focus group data provided a glimpse of the MLC participants' experiences but did not include non-participant perspectives. Future studies could benefit from exploring whether and how collaboration between administrators and coaches using a systems approach facilitates collaborative learning and shared leadership. Despite these limitations, this study identified potential points of intervention to build internal capacity in school districts for addressing complex math education problems.

Table 1

Demographic information of the survey sample (N=27)

Context	Freq.	%	Demographics	Freq.	%
School			Gender		
Elementary A	8	30%	Male	7	26%
Elementary B	7	26%	Female	20	74%
Middle school	7	26%	Race/ethnicity		
High School	5	19%	White	21	78%
MLC participation			Asian	4	15%
Participating teacher	8	30%	Other	2	8%
Coach	5	19%			
Administrator	5	19%			
Non-participant	9	33%			
Teachers (n=22)	Mean (SD)	Min-Max	Administrators (n=5)	Mean (SD)	Min-Max
Years of teaching			Years of administration		
In current school	12.25 (7.94)	0-29	In current school	2.80 (1.79)	0-4
Overall	17.05 (9.01)	0-29	Overall	7.00 (2.58)	4-10

Table 2

Focus group participants (N=28)

Group	From initial cohort of schools ^a	From later schools ^b	Total	Number of males
MLC participating teachers	7	2	9	2
Coaches, 2014-15 cohort	2	4	6	0
Coaches, 2013-14 cohort	6	0	6	2
Administrators	5	2	7	0
Total	20	8	28	4

^a Two elementary schools, one middle school, and one high school that started implementing MLC in 2013-14.

^b Two elementary schools that started implementing MLC in 2014-15.

Table 3

Perception of shared leadership and continuous improvement (N=27)

Variable	Time	Mean (SD)	Shared leadership		Continuous improvement	
			Baseline	End of year 3	Baseline	End of year 3
Shared leadership	Baseline	3.24 (0.95)	1	.422 *	.844 *	.461 *
	End of year 3	4.11 (0.60)		1	.403 *	.657 *
Continuous improvement	Baseline	3.20 (0.95)			1	.539 *
	End of year 3	3.84 (0.73)				1

* p < .05

Table 4

Collaboration domains and categories derived from focus groups

Domains and categories	Number of cases	Domains and categories	Number of cases
Collaboration between administrators and MLC participants		Pre-MLC collaboration	
Administrators provide support	17	Limited collaboration	15
Administrators provide autonomy	14	Lack of efficiency	2
Administrators check in consistently	4	Barriers to collaboration	
Administrators need to communicate clearly	4	Variation between groups	16
Administrators provide support	3	Lack of buy-in	10
Administrators create a safe environment	3	Variation within groups	7
Administrators create an unsafe environment	3	Program clarity	6
Collaboration between coaches and MLC participants		Time Constraints	5
Planning	9	Program limitations	3
Trust	6	Conditions for effective collaboration	
Distrust	2	Financial support	10
Collaboration among MLC participants		Maintaining current roles	9
Collective learning	8	Program understanding	9
Regular interaction	6	Separate coach role	7
Collaboration between coaches and non-participants		Adequate time	3
Pre-existing relationship	3	Expectations for future collaboration	
Informal collaboration	2	Continuous improvement	5
Site-wide collaboration		Positive outlook	3
Student-focus	11	Share knowledge	3
Increased collaboration	5	Teacher leadership	
Common structure	5	Leadership practice	8
Same subject	4	Leadership pressure	3
Informal site-wide collaboration	2		
Underdeveloped culture of collaboration	2		
Site-to-site collaboration			
Program Purpose	2		