Principals and Supporting the Development of Mathematics Instruction alighed with the Common Core

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School leaders whose practices have focused on instructional leadership have been consistently linked with higher levels of student achievement (Bryk, 2010; Edmonds, 1979; Leithwood, Seashore Louis, Anderson, Wahlstrom, & others, 2004; Robinson, Lloyd, & Rowe, 2008). Leithwood et al. (2004) conclude that principals are the second most important factor within schools influencing student achievement after teachers. Robinson et al. (2008) identified five instructional leadership dimensions related with higher levels of student achievement: establishing goals and expectations; resourcing strategically; planning, coordinating, and evaluating teaching and the curriculum; promoting and participating in teacher learning and development; and ensuring an orderly and supportive environment. Overall, effective instructional leaders help set the direction of the school, marshal resources to support teaching, foster ongoing support for teachers, and help establish communities of practice in which both instruction and student learning are critically analyzed.

Despite strong evidence connecting instructional leadership practices with higher student outcomes, researchers understand very little on how principals can influence the quality of instruction (Robinson, 2010; Spillane, Halverson, & Diamond, 2004; M. Stein & Spillane, 2003). This is especially problematic given the implementation of the Common Core State Standards for Mathematics (CCSS-M). Teachers will need to develop new instructional practices and new dispositions about what mathematics instruction and student learning looks like (Paul Cobb & Jackson, 2011a). I will use the term inquiry-oriented mathematics instruction as a label for instruction that is aligned with the CCSS-M. Additionally, school leaders in many school districts are expected to be central instructional leaders who press and support math teachers' improvement of their instruction, yet little is understood what school leaders need to know and do to support instructional improvement. Rowan, Raudenbush, & Cheong (1993) found that

effective principals put in place more supports around teachers as the complexity and demands of teaching increase. These findings need to be extended to clarify what school leaders can do to support teachers learning how to teach to the CCSS-M (NCTM, 2014).

Researchers on school leadership have conjectured that little is known about how instructional leadership supports instructional improvement because few studies anchor their stu dies in relation to particular student learning goals (NCTM, 2000; Neumerski, 2012; Robinson, 2010; Rowan, Raudenbush, & Cheong, 1993). That is, instructional leadership should banalyzed in relation to how it supports teachers in addressing the target student learning goals. In the case of the CCSS-M, it is likely that school leaders will need to establish conditions within their school that math educators and other researchers have found to support teacher learning. For example, the third practice standard of the CCSS-M (2010) expects teachers to support students in constructing viable arguments and critiquing the reasoning of their peers. To address this practice standard, teachers can orchestrate whole-class discussions in which different groups of students present their solution methods and explain their mathematical reasoning to their peers (M. K. Stein, Engle, Smith, & Hughes, 2008). To lead whole-class discussions effectively, teachers would need support in responding to and analyzing the validity of students' solution strategies, which could involve analyzing and rehearsing classroom discussions during teacher collaborative meetings (Kazemi, Franke, & Lampert, 2009). Principals and other instructional leaders would then be responsible for developing shared instructional goals (e.g. whole-class discussions) within the math department and also providing teachers with time and resources for teacher collaboration.

This literature review addresses the following research question:

What is known about how principals as instructional leaders can support the development of mathematics instruction that is aligned with the Common Core State Standards for Mathematics?

In addressing this question, I will summarize current research on how principals can influence the quality of mathematics instruction. This review will inform research on the knowledge, practices, and dispositions that are productive for instructional leaders when the aim is inquiry-oriented mathematics instruction. Throughout this analysis, I assert that it is not feasible at scale for principals to serve in a capacity similar to an instructional coach. Additionally, principals' effectiveness depends greatly on relationships with other instructional leaders (e.g. math coach, district math specialists, principal supervisors, etc.). It is also crucial that principals collaborate with other instructional leaders who have developed inquiry-oriented mathematics instructional practices. Without such expertise, it is unclear whether or not other instructional leaders can support principal learning.

In this literature review, I will first review the literature and discuss my conceptual framework for principal instructional leadership. Second, I will detail my methods for the literature review. Third, I will present my findings and propose key ways in which principals can directly and indirectly support inquiry-oriented mathematics instruction. Last, I will synthesize results and discuss the implications for future research. **Literature Review**

School leaders can strongly influence how instructional policies play out in schools by influencing which policy messages enter the school and which ones do not (Coburn, 2005). If principals do not support instructional policies, for example, then they can shut out those policies and instead promote or create other policies. School leaders can also ensure that teachers have time to make sense of new instructional policies and understand what implications policies have

for instruction and assessment of learning. For example, Cobb et al. (2003) reported a case in which a principal's expectations for instruction were different than those being discussed in teacher professional development. Principals valued analyzing student achievement data to optimize test performance rather than analyzing student work to determine key student misunderstandings. In this case, the principal's expectations strongly influenced which activities teachers undertook when collaborating (e.g. data analysis) and largely diverted the influence of professional development on teachers' instruction.

The ways in which school leaders interpret and communicate their understanding of policies to their staff can influence how teachers respond to and modify their instructional practices in relation to instructional policies (Coburn & Russell, 2008; Coburn, 2005; Manouchehri & Goodman, 1998). Principals can communicate instructional expectations that compromise the intention of the policy, even when they are symbolically in support of the policy (P. Cobb, McClain, de Silva Lamberg, & Dean, 2003; Coburn & Russell, 2008; Manouchehri & Goodman, 1998). Thus, it is important that principals understand the pedagogical functions of new policies and not just the forms in which instruction changes. For example, Coburn and Russell identified cases where principals were in supported of new research0based math curricula, but pressed teachers to implement it in ways that compromised its design (e.g. skipping units or presenting content out of order). Thus, if principals had a better understanding of the design of the curricula, then it is possible that they would support teachers in implementing the curricula with fidelity.

Principals will likely need ongoing support from other instructional leaders in their school and distrcits in order to understand the underlying functions of the CCSS-M and how to identify central learning goals for mathematics teachers (Burch & Spillane, 2003; P. Cobb et al., 2003;

Paul Cobb & Jackson, 2011b; Nelson & Sassi, 2005). Many principals are unfamiliar with inquiry-mathematics instruction (Nelson & Sassi, 2000) and have limited time in which to work with teachers as instructional leaders (Horng, Klasik, & Loeb, 2010). Additionally, principals have various responsibilities not related to instruction and have small packets of time for training and professional development. Without sufficient knowledge and expertise, it is possible that principals will unknowingly work with teachers in ways that compromise teachers' instruction in ways that are not aligned with the CCSS-M. Principals will need continual support in their school and district contexts, particularly as many principals do not have expertise in mathematics instruction and might promote instructional goals that are not aligned with inquiry-oriented mathematics instruction (Burch & Spillane, 2003; P. Cobb et al., 2003). Such support will also help principals identify ways in which teacher learning can be supported, whether that be through professional development, coaching, or collaborative meetings.

Conceptual Framework

In this literature review, I will argue that instructional leadership is co-constructed by leaders and followers who are enacting certain leadership tasks that fulfill instructional leadership functions that are in service of instructional goals (Spillane et al., 2004). Principals and assistant principals are key instructional leaders within a school. Department heads, coaches, and teachers can also take on roles as instructional leaders. The distinction between leaders and followers is not always designated by formal position and can vary depending on the activity at hand. Ideally, the nature of the leadership task should influence who leads its enactment and should fall along the "contours of experise" (Elmore, 2006, p.22).

The four instructional leadership functions that I will elaborate on in this review are: *sustaining an instructional vision, brokering learning opportunities, monitoring the quality of*

instruction and student learning, and fostering teacher collaboration. These leadership functions emerged from synthesizing findings and conjectures from literature reviews and theoretical perspectives on principal instructional leadership (Hallinger & Heck, 1998; Leithwood et al., 2004; Robinson et al., 2008; Spillane et al., 2004). Here, I define sustaining an instructional vision as developing, communicating, and sustaining goals for student learning and for instructional improvement. Brokering learning opportunities is defined as events in which a school leader intentionally coordinates opportunities for teachers to improve their instructional practices. These opportunities include bringing in professional development, hiring instructional coaches, and connecting teachers to those with greater instructional expertise. I define monitoring the quality of instruction and student learning as ways in which school leaders gather data on instruction, gather data on student learning, and press on the content teachers' instruction through feedback. I define fostering teacher collaboration as attempts to support teachers in working together on problems of planning, instruction, and assessment. This could include providing time for teachers to meet, setting goals for meetings, fostering trust and modeling risk taking in meetings, assigning facilitators with expertise, and providing tools to guide teachers' work during meetings.

I propose that a primary goal of principal instructional leadership is to work with teachers and other instructional leaders to establish conditions within the school that support teacher learning. I synthesized prior math education research to understand central factors that can support teachers' learning of inquiry-oriented mathematics instruction. Important conditions include a focus on a core set of high-leverage instructional practices (Ball, Sleep, Boerst, & Bass, 2009), frequent professional development on these practices that is sustained over time (Borko, 2004; Fennema et al., 1996), activities that incorporate current instructional tools in the school

context (Silver & Stein, 1996), effective facilitation of professional development and teacher collaboration by educators who have developed target practices (Carpenter, Fennema, Franke, Levi, & Empson, 2000), opportunities for analysis of representations from classroom instruction, opportunities for rehearsals of high-leverage practices, and ongoing instructional feedback on target instructional practices. Such features of professional development have been linked with the development of inquiry-oriented mathematics instruction (Wilson, 2013).

Methods

I conducted searches using ERIC (www.eric.gov) to identify sources that aligned with my research question: What is known about how principals as instructional leaders can support the development of inquiry-oriented mathematics instruction? I constructed the following search term by identifying common search terms from seminal papers on instructional leadership (Fink & Resnick, 2001; Hallinger & Heck, 1998; Leithwood et al., 2004; M. K. Stein & Nelson, 2003): +descriptor:"instructional leadership" +descriptor:(leadership OR "teacher administrator" OR principals OR "assistant principals") AND("Teaching Methods" OR "Teaching Skills" OR "Instructional Improvement") -descriptor: "Teacher Leadership." . My main search returned 211 peer-reviewed articles. After reading each of the 211 abstracts, I found that few studies examined the relationship between principal leadership and teachers' instruction, and even fewer studies examined how principal instructional leadership related to inquiry-oriented mathematics instruction. I therefore decided to include sources that addressed general instructional goals as well as those that focused specifically on inquiry-oriented mathematics instruction.

To synthesize more of the research literature, I decided to also include studies that made theoretical conjectures on how principal instructional leadership could influence instruction. I made this decision because several studies didn't observe changes in instruction, but conjectured

how principals' practices could lead to changes in instruction. For example, Ing (2010) found a positive relationship between principals' observation behaviors and the nature of teacher collaboration. Ing (2010) conjectured that increased teacher collaboration would likely have a positive influence on instruction. This study illustrates both gaps and consistent findings that I encountered in my review: lack of clear evidence on how principal instructional leadership influenced instruction *and* a consistent proposition that principals are integral in promoting teacher collaboration. In another example, Stein and Nelson (2003) studied the observation and feedback practices of a principal who used an observation tool that communicated the importance of student group work in inquiry classrooms. The observation tool also indicated the importance of students forming and testing their own mathematical conjectures. Student collaboration and testing of conjectures is central in inquiry-oriented mathematics instruction (M. K. Stein et al., 2008), and is emphasized in the practice standards of the CCSS-M. Stein and Nelson did not record how instruction changed, but there is evidence that this observation and feedback process had the potential to influence which tasks were selected for instruction and how these tasks were implemented. Thus, I included both studies in this review because they provide additional conjectures on how instructional leadership can support instructional improvement.

I applied my two inclusion criteria – analysis of how principals influenced instruction or hypotheses about how principal instructional leadership could influence instruction – as I read through all 211 abstracts. I retained 60 research articles for further consideration. After reading each article, I then eliminated articles that did not make clear connections between leadership and instruction or reasonably conjecture about this connection. Additionally, some sources were dropped because they did not clearly lay out their frameworks and research methodologies. Twenty-nine sources were retained for my review. From here, I also snowballed additional

potentially relevant studies based on checking citations of the retained sources, which led to the identification of an unpublished dissertation (Schoen, 2010).

While reading the retained studies, I formed two categories based on theoretical and methodological similarities: *Professional Community*, and *Policy Implementation and Expertise*. These categories are not inherently mutually exclusive, but indicate the overall focus of particular studies.

Studies categorized in the Professional Community section tended to view the principal as central for catalyzing organizational, instructional, and cultural changes in the school. These studies used statistical regression methods to find relationships between teachers' perceptions of principal instructional leadership and measures of instruction. Professional Community studies often accounted for mediators such as teacher collaboration activities and norms (e.g. sharing resources, shared commitments to student learning, etc.) and levels of relational trust within the school.

Policy Implementation and Expertise studies were typically case studies that aimed to understand how effective principals implemented instructional polices as they collaborated with teachers. These studies tended to focus on the decisions and practices that principals made to ensure successful implementation of instructional policies over time. They highlighted principal expertise in various instructional leadership practices to differentiate effective principals from those who were less effective in reform efforts. For example, in one study, effective principals were those who consistently brought in coherent and content-based professional development to support teachers in learning Balanced Literacy instruction (Graczewski, Knudson, & Holtzman, 2009).

While reviewing each study, I searched for how researchers attended to the relationships between student learning goals, instruction, and instructional leadership. I took the perspective that the content of student learning goals should shape instructional leadership. Although it is generally acknowledged that research should clarify how instructional leadership supports student learning with respect to particular goals, this connection is rarely analyzed (Neumerski, 2012; Robinson, 2010; Rowan et al., 1993; M. K. Stein & Nelson, 2003). For each study, I took into account principals' behaviors, how it related to the student learning goals in the study, and accounts on how principal instructional leadership influenced instruction. In addition, I analyzed what principals did in relation to aspects of effective professional development. I used these analyses to identify instructional leadership tasks that further elaborate on the four focal instructional leadership functions in this study.

For the studies in which student learning goals were aligned with the CCSSM, I analyzed how instructional leadership practices related to aspects of high-quality professional development. For studies with general student learning goals, I analyzed principal practices and then determined if these practices were likely to support teachers' development of inquiry-oriented instruction by comparing what principals did to aspects of effective professional development. From this perspective, I conjectured how principals' practices might be adapted to support instructional improvement that is compatible with the CCSS-M, thereby adding to my understanding of which leadership tasks are supportive of teachers developing inquiry-oriented mathematics instruction. For instance, if the study focused on how principals supported teacher collaboration, I analyzed the focus of teacher collaboration, what kinds of activities were documented, and if teacher collaboration was led by someone with instructional expertise. If teachers mainly shared instructional strategies, I then conjectured that these activities are

unlikely to support teachers in improving instruction aligned with CCSSM unless it was normative for teachers to engage in discourse on the pedagogical functions of such strategies (i.e. pedagogies of investigation).

Last, I summarized findings into leadership tasks and categorized each task under its associated instructional leadership function: sustaining an instructional vision, brokering learning opportunities, monitoring the quality of instruction and student learning, and fostering teacher collaboration. .

Results

To understand how principal instructional leadership can influence the quality of mathematics instruction and instruction in general, I conducted a literature review and synthesized findings from twenty-nine studies. I divided the pertinent studies into two categories: Professional Community Studies (9 Studies), and Policy Implementation Studies (20 Studies). In this section, I will present results for Professional Community Studies (9 Studies) and then for Policy Implementation Studies (20 Studies). Then, I will synthesize these findings according to leadership function and task.

Findings from Professional Community Studies

Professional Community studies generally used quantitative methods to investigate relationships between principal instructional leadership and instructional vision, aspects of the school culture, and teachers' instructional practices (Marks & Printy, 2003; Printy, 2008, 2008; Sebastian & Allensworth, 2012; Wahlstrom & Louis, 2008). Findings from Professional Community studies consistently indicated that principals in schools with high levels of instruction were often able to foster a shared instructional vision, high levels of relational trust, high levels of shared leadership, high expectations for student learning and instruction, shared

commitments towards improving student learning, and teacher collaboration that focused on planning and sharing resources. These studies overall though did not make clear connections between goals for improving student learning and instruction, principals' practices, and instructional improvement. In the absence of such connections, it is unclear how principal instructional leadership related to instructional improvement. Furthermore, the majority of the activities reported are unlikely to support teacher learning of inquiry-math.

Additionally, eight of the nine studies in this category used self-report survey measures for classroom instruction. Self-report measures are prone to issues of internal and external validity, particularly when these measures assess complex instructional practices (Dunlap et al., 2015). Self-report measures can be problematic when measuring inquiry instruction because key terms and phrases used in survey scales can have multiple meanings (e.g. rigor). Furthermore, prior research in mathematics education indicates that teachers might not accurately judge their instructional practice, particularly when learning new and unfamiliar instructional practices (Cohen, 1990; Spillane, 2000). Thus, findings from Professional Community studies provide a constellation of contemporaneous characteristics of schools (e.g. high expectations for student learning, relational trust, shared leadership) that relate to high teacher self-report measures of instruction, but there is no clear indication on how instructional leadership practices shaped mathematics instruction.

Findings from Policy Implementation and Expertise

Findings from Policy Implementation and Expertise studies point to the importance of instructional leaders communicating a coherent set of goals for student learning and goals for instructional improvement, (Graczewski et al., 2009), aligning professional development with these goals (Youngs & King, 2002), supporting instructional coaches to align their practices with

the broader instructional vision (Higgins & Bonne, 2011), and sustaining instructional policies and supports for multiple school years (Graczewski et al., 2009; Higgins & Bonne, 2011; Youngs & King, 2002). Furthermore, principals were more likely to to broker opportunities for content-specific professional development and content coaching when they were more involved as instructional leaders (Burch & Spillane, 2003; Gibbons, 2012; Graczewski et al., 2009). Common instructional leadership practices included frequently observing classrooms, attending teacher collaborative meetings, and attended teacher professional development with their teachers. Importantly, these studies did not fully report the content and enactment of these practices. Thus, there is evidence on the form of instructional leadership, but not on what school leaders need to know, do, and be.

Several Policy Implementation and Expertise studies found that effective configurations of instructional leadership often involved multiple instructional leaders (e.g. principal and coach) who served different functions (Burch & Spillane, 2003; Gibbons, 2012; Higgins & Bonne, 2011; Mangin, 2007). For example, principals typically evaluate teachers, have considerable influence over the design organization of the school, and have authority over matters relating to the school budget, hiring, and procuring resources external to the school. The instructional coach position can be designed to provide ongoing content-specific professional development for individual teachers and for groups of teachers (Burch & Spillane, 2003; Gibbons, 2012; Higgins & Bonne, 2011). A few studies point to a synergistic effect when principals and coaches collaborate, have compatible instructional visions, and fulfill complementary roles (Gibbons, 2012; Higgins & Bonne, 2011). When principals and instructional coaches coordinate their instructional leadership practices, there is potential to both redesign the school and procure key

resources, as well as to provide ongoing, intensive support for teachers on high-leverage instructional practices.

Importantly, though, changes in instruction in these studies were not necessarily consistent with those required for instruction compatible with the CCSS-M (Higgins & Bonne, 2011; Huggins, Scheurich, & Morgan, 2011; Timperley, 2005). In one study, Huggins et al. (2011) presented a discussion from a teacher collaborative meeting in which teachers shared strategies for teaching students how to find the y-intercept when given a linear equation. The math teachers discussed covering up a line around the y-axis as a strategy because it visually isolates the point on the graph where the line crosses the y-axis. Although such sharing can provide teachers with additional strategies that they can easily convey to students in the classroom, such strategies do not support students in developing a conceptual understanding of mathematical concepts. Thus, although studies under Policy Implementation and Expertise Studies provided important evidence for how to implement instructional policies, there was insufficient evidence on teachers reorganizing their practice in ways that align with inquiry-math instruction.

Summary of Leadership Tasks by Leadership Function

In sum, findings from both sets of studies add to the instructional leadership field's understanding of how principal instructional leadership influences instruction. Table 1 synthesizes findings of the literature review by leadership function, instructional leadership tasks within each function, and outcomes from the literature. As discussed throughout the Results section, findings from this literature review offer more insight on how principals as instructional leaders can support teachers, rather than how such supports related to improving the quality of mathematics instruction as it relates to the CCSS-M.

Table 1: Leadership Fuctions, Tasks, and Outcomes

Leadership Functions	Leadership Tasks	Outcomes
Developing and Sustaining an Instructional Vision	Work with Staff to identify goals for student learning and for instruction (Burch & Spillane, 2003; Datnow & Castellano, 2001; Fletcher, Grimley, Greenwood, & Parkhill, 2013; Graczewski et al., 2009; Higgins & Bonne, 2011; Huggins et al., 2011; Kurland, Peretz, & Hertz-Lazarowitz, 2010; Marks & Printy, 2003; McGhee & Lew, 2007; Timperley, 2005; Youngs & King, 2002)	Staff can come to a consensus on goals for instruction, which can serve as foundation for coherent professional development (Graczewski et al., 2009), identify those with relevant expertise (Higgins & Bonne, 2011), highlight key activities for teacher collaboration (Youngs & King, 2002), and highlight ways of monitoring instruction and student learning (Nelson & Sassi, 2005)
	Interact with teachers and continually communicate expectations and goals for student learning and instruction (Coburn & Russell, 2008; Coburn, 2005; Katterfeld, 2013; Manouchehri & Goodman, 1998)	Teachers understand key performance outcomes. Certain policy messages can be shut out, while others promoted (Coburn 2005). Strong influence over implementation of reform curricula and new ways of thinking about instruction (Manouchehri & Goodman, 1998). Strong influence over how teachers perceive and use new instructional tools (Coburn & Russell, 2008)..
	Sustain support around vision for multiple years (Graczewski et al., 2009; Higgins & Bonne, 2011; Manouchehri & Goodman, 1998; Youngs & King, 2002)	Greater likelihood of policy implementation and instructional change (Graczewski et al., 2009), greater likelihood of sustained coherent PD (Graczewski et al., 2009; Higgins and Bonne, 2011; Youngs & King, 2002)
Brokering learning opportunities	Ensure PD is coherent, sustained aligned with goals for student learning and instruction (Datnow & Castellano, 2001; Fletcher et al., 2013; Graczewski	Associated with higher levels of teacher reports on critical thinking and discourse (Sebastian &

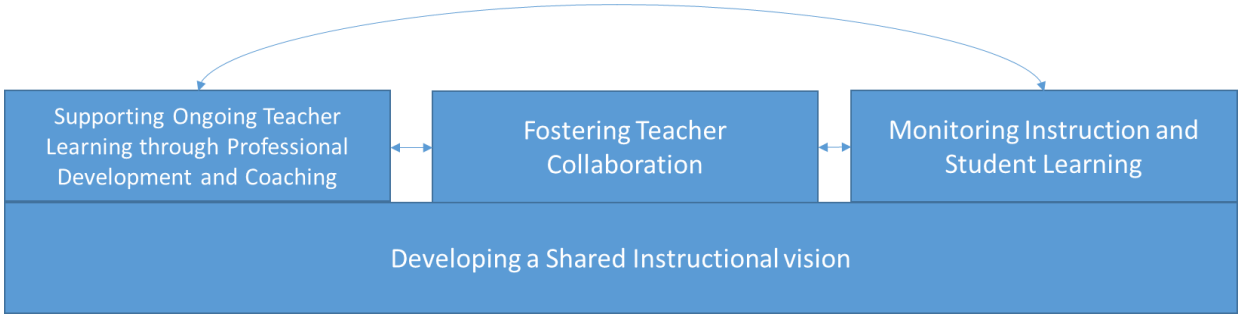
	et al., 2009; Higgins & Bonne, 2011, 2011; Sebastian & Allensworth, 2012; Youngs & King, 2002)	Allensworth, 2012) and gains knowledge, skills, and dispositions in SFA (Youngs & King, 2002)
	Identify, support, and meet instructional coaches, teacher leaders, those with expertise in order to provide ongoing support for teachers (Gibbons, 2012; Higgins & Bonne, 2011; Mangin, 2007)	Teachers have opportunities to work with those with expertise on goals for instruction (Higgins & Bonne, 2011); More teachers seek out coach (Gibbons, 2012)
	Bring in content-based PD focused on developing planning, instruction, and assessment practices (Burch & Spillane, 2003; Fletcher et al., 2013; Graczewski et al., 2009; Mangin, 2007; McGhee & Lew, 2007; Timperley, 2005)	Teachers feel more supported(McGhee & Lew, 2007); teachers more likely to change instructional practices along policy lines (Graczewski et al., 2009)
fostering teacher collaboration	Build in time and re-organize organization to allow for teacher collaboration time (e.g. who attends, who facilitates) (Coburn, 2005; Manouchehri & Goodman, 1998)	Helps teachers make sense of new instructional policies and how this influences instruction and assessment of student learning (Coburn, 2005). Helps teachers implement new policies (Coburn, 2005; Manouchehri & Goodman, 1998)
	Communicate Expectations for activities conducted during Collaboration (Blanc et al., 2010; Coburn, 2005; Graczewski et al., 2009; Huggins et al., 2011; Timperley, 2005; Youngs & King, 2002)	Can Influence teachers to share instructional strategies (Huggins et al., 2011), identify students for intervention (Blanc et al., 2010), and can influence the quality of assessments teachers use (Timperley, 2005)
monitoring the quality of instruction and student learning	Consistent feedback to teachers based on tasks and task implementation (Nelson and Sassi, 2005)	Can influence the math tasks that teachers select for students and how they guide students' work on those tasks (Nelson and Sassi, 2005)
	Monitor instruction, attend meetings, and interact with teachers and teacher leaders to identify content-specific	School leaders are better positioned to identify goals for improving student

	support for teachers (Blase & Blase, 2000; Burch & Spillane, 2003; Gibbons, 2012; Graczewski et al., 2009; Mangin, 2007; Timperley, 2005, 2005)	learning and instructional improvement (Burch & Spillane, 2003). Better positioned to bring in content-specific support for teachers and improve instruction (Graczewski et al., 2009). Better understanding of who has expertise, which could inform who facilitates teacher collaboration, who coaches teachers, and what activities take place during teacher collaboration (Timperley, 2005; Burch & Spillane, 2003; Gibbons, 2012; Mangin, 2007).
	Regularly provide feedback to promote teacher reflection and professional growth (Blase & Blase, 2000; Ing, 2010)	Teachers have a better understanding of how to improve student learning and instructional practices generally (Blase and Blasé, 2000). Greater levels of teacher collaboration and shared commitments to student learning in schools where feedback is given as a means of PD rather than evaluation (Ing, 2010).

It is important here to point out possible interconnections between these instructional leadership functions (refer to Figure 1). For example, when staff establish goals for student learning and instruction, this also shapes the content and activities of teacher collaboration and teacher professional development (Coburn, 2006). Reflexively, the goals and activities conducted during teacher collaboration and professional development can change learning goals for students and teachers over time and thus reshape the instructional vision. Similarly, the goals for student learning and teacher learning influence what principals look for when observing

instruction. Also, through monitoring instruction, school leaders might identify new instructional issues, which could then reshape goals for teacher learning, which in turn influences the content of professional development as well as the goals for teacher collaboration. Foundational throughout is the need to establish shared goals for student learning and shared goals for instruction.

Figure 1: Interdependencies between various instructional leadership functions



Conclusions

indings from the Professional Community Studies and Policy Implementation studies have several implications for what principals need to be able to know and do to support teachers' development of inquiry-oriented instructional practices. School leaders will need to collaborate with teachers and instructional experts to establish shared goals for improving student learning and instruction in ways that are compatible with the CCSS-M. Additionally, principals will need to be able to identify high quality enactments of inquiry-oriented mathematics instruction. That is, principals need to be able to identify key teacher-student interactions to assess how/if instruction is supporting students in learning the content and practice standards of the CCSS-M. Third, it is important to align the goals and activities of professional development and teacher collaboration with the broader goals for student learning and instruction. Thus, principals need to be able to participate in teacher collaborative meetings to ensure that the focus of these meetings stays on improvement goals and to support facilitators of these meetings.

In conclusion, school leaders can play an important albeit indirect role in supporting instructional improvement aligned with the CCSSM. Throughout this analysis, there was substantial evidence indicating that school leaders' influence on instruction was primarily indirect, and that school leaders will need support in identifying goals for teacher learning. Within the context of school districts, this indicates the necessity of ongoing collaboration between principals, instructional coaches, district math specialists, and principal supervisors. Such collaboration can help form a shared vision for instruction as well as coordinate and mobilize resources. Furthermore, most principals do not have the time or the expertise to work intensively with teachers on instructional practices. Instead, direct support should come from school-based coaches, district math specialists, or other teachers with expertise. Therefore, principals' effectiveness as instructional leaders over mathematics depends highly on their institutional settings.

It is unlikely that principals will be able to support teachers in developing instruction that is compatible with the CCSS-M unless there is a coherent system of supports around the principal and throughout the school district, per se. Such a coherent system includes a shared, district-wide vision of mathematics instruction, research-based curricula that align with the CCSS-M, educators throughout the district with sophisticated instructional practices who can support teacher learning, ongoing professional development on high-leverage instructional practices, and organizational routines within the school that focus on the analysis of instruction and evidence of student learning. Even with all the aforementioned pieces in play, principals still play key roles in fostering a shared vision of instruction within their school, pressing teachers on instructional practices that align with the CCSS-M, positioning expertise within the school, and strategically using resources with the school to sustain the school vision. Leveraging Elmore's concept of

reciprocity and capacity, principals would need adequate support in developing a functional understanding of mathematics instruction in order to observe and collaborate with teachers and coaches.

One key limitation in this review is that it doesn't take into account how high-stakes accountability testing can constrict the processes of teaching and learning mathematics within schools. Accountability pressures and strains from high-stakes testing are common and have been found to limit what is taught to what will be on the test(Crocco & Costigan, 2007). Given the complexity of inquiry-oriented mathematics instruction, pressure to meet Adequate Yearly Progress might limit the scope of what is perceived as an effective solution path to a path that is data driven and based on re-teaching standards with low performance. Thus, curtailing the complexities of learning and developing new, complex instructional practices.

Future research work should investigate both how principals form instructional visions consistent with the Common Core and inquiry math, and how they enact such visions. Preliminary findings indicate that how principals frame the problem of improving student learning and improving instruction has implications for the nature and kind of supports provided for teachers' learning. Additionally, current results indicate that principals with a more sophisticated understanding of inquiry mathematics instruction are more likely to identify central problems that current impede teachers' development. These findings could have implications for how school leaders are supported by school districts, and also for how school leaders can foster conditions within their school to support the development of inquiry math instruction.

References

Ball, D. L., Sleep, L., Boerst, T. A. & Bass, H. (2009). Combining the development of practice and the practice of development in teacher education. *The Elementary School Journal*, *109*(5), 458–474.

Blanc, S., Christman, J. B., Liu, R., Mitchell, C., Travers, E. & Bulkley, K. E. (2010). Learning to learn from data: Benchmarks and instructional communities. *Peabody Journal of Education*, *85*(2), 205–225.

Blase, J. & Blase, J. (2000). Effective instructional leadership: Teachers' perspectives on how principals promote teaching and learning in schools. *Journal of Educational Administration*, *38*(2), 130–141.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, *33*(8), 3–15.

Bryk, A. S. (2010). Organizing schools for improvement. *Phi Delta Kappan*, *91*(7), 23–30.

Burch, P. & Spillane, J. P. (2003). Elementary school leadership strategies and subject matter: Reforming mathematics and literacy instruction. *The Elementary School Journal*, 519–535.

Carpenter, T. P., Fennema, E., Franke, M. L., Levi, L. & Empson, S. B. (2000). Cognitively Guided Instruction: A Research-Based Teacher Professional Development Program for Elementary School Mathematics. Research Report.

Cobb, P. & Jackson, K. (2011a). Assessing the quality of the common core state standards for mathematics. *Educational Researcher*, *40*(4), 183–185.

Cobb, P. & Jackson, K. (2011b). Towards an Empirically Grounded Theory of Action for Improving the Quality of Mathematics Teaching at Scale. *Mathematics Teacher Education \& Development*, *13*(2).

Cobb, P., McClain, K., de Silva Lamberg, T. & Dean, C. (2003). Situating teachers' instructional practices in the institutional setting of the school and district. *Educational Researcher*, *32*(6), 13–24.

Coburn, C. E. (2005). Shaping teacher sensemaking: School leaders and the enactment of reading policy. *Educational Policy*, *19*(3), 476–509.

Coburn, C. E. (2006). Framing the problem of reading instruction: Using frame analysis to uncover the microprocesses of policy implementation. *American Educational Research Journal*, *43*(3), 343–349.

Coburn, C. E. & Russell, J. L. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis*, *30*(3), 203–235.

Cohen, D. K. (1990). A revolution in one classroom: The case of Mrs. Oublier. *Educational Evaluation and Policy Analysis*, *12*(3), 311–329.

Crocco, M. S. & Costigan, A. T. (2007). The narrowing of curriculum and pedagogy in the age of accountability urban educators speak out. *Urban Education*, *42*(6), 512–535.

Datnow, A. & Castellano, M. E. (2001). Managing and guiding school reform: Leadership in success for all schools. *Educational Administration Quarterly*, *37*(2), 219–249.

Edmonds, R. (1979). Effective schools for the urban poor. *Educational Leadership*, *37*(1), 15–24.

Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R. & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education*, 403–434.

Fink, E. & Resnick, L. B. (2001). Developing principals as instructional leaders. *Phi Delta Kappan*, *82*(8), 598–610.

Fletcher, J., Grimley, M., Greenwood, J. & Parkhill, F. (2013). Raising reading achievement in an "at risk", low socioeconomic, multicultural intermediate school. *Journal of Research in Reading*, *36*(2), 149–171.

Gibbons, L. K. (2012). *Examining Mathematics Coaches in Supporting Teachers to Develop Ambitious Instructional Practices: A Three-paper Dissertation Investigating Context, Knowledge, and Practice*.

Graczewski, C., Knudson, J. & Holtzman, D. J. (2009). Instructional leadership in practice: What does it look like, and what influence does it have? *Journal of Education for Students Placed at Risk*, *14*(1), 72–96.

Hallinger, P. & Heck, R. H. (1998). Exploring the Principal's Contribution to School Effectiveness: 1980-1995∗. *School Effectiveness and School Improvement*, *9*(2), 157–191.

Higgins, J. & Bonne, L. (2011). Configurations of instructional leadership enactments that promote the teaching and learning of mathematics in a New Zealand elementary school. *Educational Administration Quarterly*, *47*(5), 794–825.

Horng, E. L., Klasik, D. & Loeb, S. (2010). Principal's time use and school effectiveness. *American Journal of Education*, *116*(4), 491–523.

Huggins, K. S., Scheurich, J. J. & Morgan, J. R. (2011). Professional learning communities as a leadership strategy to drive math success in an urban high school serving diverse, low-income students: A case study. *Journal of Education for Students Placed at Risk*, *16*(2), 67–88.

Ing, M. (2010). Using informal classroom observations to improve instruction. *Journal of Educational Administration*, *48*(3), 337–358.

Katterfeld, K. (2013). Setting Instructional Expectations: Patterns of Principal Leadership for Middle School Mathematics. *Leadership and Policy in Schools*, *12*(4), 337–373.

Kazemi, E., Franke, M. & Lampert, M. (2009). Developing pedagogies in teacher education to support novice teachers' ability to enact ambitious instruction. In *Crossing divides: Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia* (Vol. 1, pp. 12–30).

Kurland, H., Peretz, H. & Hertz-Lazarowitz, R. (2010). Leadership style and organizational learning: the mediate effect of school vision. *Journal of Educational Administration*, *48*(1), 7–30.

Leithwood, K., Seashore Louis, K., Anderson, S., Wahlstrom, K. & others. (2004). Review of research: How leadership influences student learning.

Mangin, M. M. (2007). Facilitating elementary principals' support for instructional teacher leadership. *Educational Administration Quarterly*, *43*(3), 319–357.

Manouchehri, A. & Goodman, T. (1998). Mathematics curriculum reform and teachers: Understanding the connections. *The Journal of Educational Research*, *92*(1), 27–41.

Marks, H. M. & Printy, S. M. (2003). Principal leadership and school performance: An integration of transformational and instructional leadership. *Educational Administration Quarterly*, *39*(3), 370–397.

McGhee, M. W. & Lew, C. (2007). Leadership and writing: How principals' knowledge, beliefs, and interventions affect writing instruction in elementary and secondary schools. *Educational Administration Quarterly*, *43*(3), 358–380.

Nelson, B. S. & Sassi, A. (2000). Shifting approaches to supervision: The case of mathematics supervision. *Educational Administration Quarterly*, *36*(4), 553–584.

Nelson, B. S. & Sassi, A. (2005). *The effective principal: Instructional leadership for high-quality learning*. Teachers College Press.

Neumerski, C. M. (2012). Rethinking Instructional Leadership, a Review: What Do We Know About Principal, Teacher, and Coach Instructional Leadership, and Where Should We Go From Here? *Educational Administration Quarterly*.

Printy, S. M. (2008). Leadership for teacher learning: A community of practice perspective. *Educational Administration Quarterly*, *44*(2), 187–226.

Robinson, V. M. (2010). From instructional leadership to leadership capabilities: Empirical findings and methodological challenges. *Leadership and Policy in Schools*, *9*(1), 1–26.

Robinson, V. M., Lloyd, C. A. & Rowe, K. J. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly*, *44*(5), 635–674.

Rowan, B., Raudenbush, S. W. & Cheong, Y. F. (1993). Teaching as a nonroutine task: Implications for the management of schools. *Educational Administration Quarterly*, *29*(4), 479–500.

Sebastian, J. & Allensworth, E. (2012). The Influence of Principal Leadership on Classroom Instruction and Student Learning A Study of Mediated Pathways to Learning. *Educational Administration Quarterly*, *48*(4), 626–663.

Silver, E. A. & Stein, M. K. (1996). The Quasar Project The“ Revolution of the Possible” in Mathematics Instructional Reform in Urban Middle Schools. *Urban Education*, *30*(4), 476–521.

Spillane, J. P. (2000). *District leaders' perceptions of teacher learning*. Consortium for Policy Research in Education, University of Pennsylvania, Graduate School of Education.

Spillane, J. P., Halverson, R. & Diamond, J. B. (2004). Towards a theory of leadership practice: A distributed perspective. *Journal of Curriculum Studies*, *36*(1), 3–34.

Stein, M. K., Engle, R. A., Smith, M. S. & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning*, *10*(4), 313–340.

Stein, M. K. & Nelson, B. S. (2003). Leadership content knowledge. *Educational Evaluation and Policy Analysis*, *25*(4), 423–448.

Stein, M. & Spillane, J. (2003). Research on teaching and research on educational administration: Building a bridge. *AERA Division A Task Force for the Development of an Agenda for Future Research on Educational Leadership*.

Timperley, H. S. (2005). Instructional leadership challenges: The case of using student achievement information for instructional improvement. *Leadership and Policy in Schools*, *4*(1), 3–22.

Wahlstrom, K. L. & Louis, K. S. (2008). How teachers experience principal leadership: The roles of professional community, trust, efficacy, and shared responsibility. *Educational Administration Quarterly*, *44*(4), 458–495.

Wilson, J. (2013). *Supporting Teachers' Development of Ambitious Teaching Practices: An Examination of the Design and Enactment of High-Quality Professional Development* .

Youngs, P. & King, M. B. (2002). Principal leadership for professional development to build school capacity. *Educational Administration Quarterly*, *38*(5), 643–670.