The Role of Teacher Leadership in How Principals Influence Classroom Instruction and Student Learning

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School principals can play an important role in promoting teacher leadership by delegating authority and empowering teachers in ways that allow them influence in key organizational decisions and processes. However, it is unclear whether instruction and student learning are enhanced by promoting teacher influence in all aspects of school organization or whether it is better for principals to directly work on certain processes while delegating influence on others. We compare pathways from principal leadership through school organizational processes to student outcomes that include teacher influence as a mediating factor to pathways that do not include teachers' influence. Our results suggest that effective principals use teacher leadership to improve the school learning climate while they work directly on professional development and school program coherence.

How do systems of leadership involving principals, teachers, and other school personnel function to improve school processes and student learning? Despite more than 4 decades of school leadership research, our understanding of how leadership systems connect to teaching and learning is far from complete (Crawford 2012; Harris et al. 2007; Leithwood et al. 2008; Leithwood and Jantzi 1999, 2000b; Neumerski 2013). Whereas early school leadership research focused solely on the role of the school principal, recent research has conceived of school leadership more broadly to include roles of teachers and

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other personnel (Hallinger and Heck 2010a, 2010b; Heck and Hallinger 2010; Supovitz 2013; Supovitz et al. 2010). However, leadership studies still tend to examine the influence of separate domains or sources (e.g., principal, teacher leaders, instructional coach) individually rather than how they work together to influence school outcomes. When studies have integrated multiple sources of leadership, such as principal and teacher leadership, they typically combine them under conceptualizations such as collaborative (Hallinger and Heck 2010a, 2010b; Heck and Hallinger 2010), shared (Louis, Dretzke, et al. 2010; Marks and Printy 2003), collective (Leithwood and Mascall 2008), or schoolwide distributed leadership (Heck and Hallinger 2009; Jackson and Marriott 2012; Leithwood and Jantzi 1998). Empirical studies integrating multiple leadership roles are relatively rare, leaving significant gaps in our understanding of how integrated leadership systems link to student learning (Dumay et al. 2013; Johnson et al. 2014; Leithwood and Jantzi 1999, 2000a, 2000b; Neumerski 2013).

In this study, we examine principal and teacher leadership as separate but linked sources of leadership that have a directional relationship. In this conceptualization, teacher leadership results at least partly from principal leadership, reflecting active efforts from a school principal to delegate influence and empower teachers. Traditional hierarchical school structures and the authority of school principals allow them to do many things teachers and others cannot (Harris et al. 2007; Neumerski 2013), including promote teacher leadership roles, develop leadership capacity (Barnett and McCormick 2012; Slater 2008), and organize a culture of collaborative and participative decision making (Hallinger and Heck 2009; Johnson et al. 2014). The central role of principals in developing distributed leadership is recognized in theory, but few empirical studies have examined how principal leadership influences leadership among school personnel, especially teachers, or how multiple sources of leadership together relate to school improvement.

We use structural equation modeling (SEM) to test a conceptual model of school organization that links principal and teacher leadership to instruction

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and learning through multiple mediating factors, including school climate, program coherence, professional development, and parental involvement. Understanding the mechanisms through which leadership influences student achievement is critical for improving leaders' capacities. Leaders have many competing responsibilities, and it is not always clear which aspects of their work matter most for student outcomes. In this study we examine the processes through which principals have a direct influence on instruction and student achievement and those mediated through teacher leadership.

Overview of Literature

Research on school leadership and school effectiveness has shown that leadership has significant, but indirect, effects on student achievement (Hallinger 2005; Hallinger and Heck 1996a, 1996b, 1998; Leithwood et al. 2004; Louis, Leithwood, et al. 2010; Sebastian and Allensworth 2012). Yet, the organization of much of school leadership research into separate domains or sources—principal, teacher, coach—has limited our understanding of how they interact with one another and ultimately influence teaching and learning (Neumerski 2013). Early conceptions of school leadership around a solitary heroic leader, "the great man" (Leithwood and Mascall 2008, 529), has given way to research that includes actors other than the school principal, such as department heads, teachers, and instructional coaches. Much of this research has been done with an isolated focus on alternative leaders; studies integrating the leadership roles of principals, teachers, and other school personnel are relatively few (Neumerski 2013). Researchers have noted that this approach of focusing on isolated leadership roles is fundamentally flawed, as it does not reflect the way schools are actually organized and how leaders function in reality (Leithwood and Mascall 2008; Neumerski 2013).

An important development in leadership research is the idea of distributed leadership, which emphasizes that school leadership is located in formal and informal interactions among principals, teachers, and other personnel (Spillane 2006). Although this conceptualization of school leadership has gained widespread acceptance in theory, the empirical base for distributed leadership is still emerging (Hallinger and Heck 2009; Harris et al. 2007). So far, attempts to capture distributed leadership have often simply combined multiple sources of leadership under conceptualizations such as shared, collaborative, and collective school leadership. Leithwood and Mascall (2008), for example, used the term collective leadership to include the joint effects of all sources of leadership, including principals, teachers, parents, students, and community members. Hallinger and Heck (2010a) described team-oriented, shared, and collaborative

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leadership as similar concepts that collectively combine both formal and informal leadership roles. Researchers have also operationalized distributed leadership as similar to shared and collaborative leadership. Harris et al. (2007) suggested that "distributed leadership has become a convenient way of labeling all forms of shared leadership activity" (338).

Shared, collaborative, and collective conceptualizations of leadership are significant improvements over those focusing solely on the role of the principal, but they mask the complexity with which leadership systems work in real schools. Specifically, they underplay the role of the principal in influencing how distributed leadership develops in schools. Leithwood and Mascall (2008) studied leadership from multiple sources that included principals, parents, students, formal teacher leaders, and individual teachers and concluded that the influence of these sources reflected a traditional hierarchical leadership model; the influence of traditional sources such as principals and assistant principals was much higher than that of nontraditional sources (teachers, staff, etc.). Their work also suggests that when distributed leadership is strong in schools, traditional sources of leadership play an active role in determining its form and influence. Although all teacher leadership need not be a result of principals' initiative, principal leadership is often a key factor (Barth 2001; Crowther et al. 2002; York-Barr and Duke 2004). Johnson et al. (2014) also noted that "repeatedly, researchers have found that the principal is pivotal in making teachers' involvement possible and shaping the nature of their contribution to school improvement" (6). Thus, while many aspects of teacher leadership or distributed leadership in school personnel can develop organically, at least some of it results from the direct leadership efforts of principals. In turn, principals work through other leaders to develop school organizational supports and processes by delegating authority and responsibility, empowering teachers and school personnel, and involving others in setting schools' direction and organizing their daily operations.

The hierarchical leadership connection from principals to other sources of leadership such as teachers is formally recognized in theory and consistently emphasized in literature, but few empirical studies have included this directional relationship when studying how systems of leadership connect to school processes and school outcomes (Neumerski 2013; York-Barr and Duke 2004). In this study we examine the relationship between two important sources of leadership in schools—principal and teacher leadership—and examine how they are in turn related to student achievement gains. Principals have numerous responsibilities for keeping schools running and improving school outcomes. Supovitz et al. (2010) reviewed existing research and suggested three main sets of activities that are commonly referenced in most leadership studies: setting school goals and mission, encouraging trust and collaboration, and actively supporting instruction. These responsibilities have come to be commonly referenced

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as components of instructional leadership, a concept that has received considerable attention in educational research (Hallinger 2005; Hallinger and Heck 1998) and is the central focus of our examination of principal leadership in this study.

Research on the role of teachers as school leaders is more recent but still goes back as far as the 1980s (York-Barr and Duke 2004). The roles for teachers described in the leadership literature include both instructional and school organizational leadership roles at formal and informal capacities (Harris 2003; Harris and Muijs 2002; Neumerski 2013; Smylie 1995; York-Barr and Duke 2004). However, a working definition of teacher leadership and a clear understanding of specific activities of teacher leaders that are important for school improvement has not yet emerged (Neumerski 2013; Stoelinga and Mangin 2010; York-Barr and Duke 2004). Teacher influence in core areas of school organization has often been the focus of quantitative studies of teacher leadership (Jackson and Marriott 2012; Louis, Dretzke, et al. 2010).

A few studies have examined the direct relationships between principal and teacher leadership (e.g., Marks and Nance 2007; Marks and Printy 2003; Printy et al. 2009; Supovitz et al. 2010; Youngs and King 2002), but empirical research is limited on how these relationships extend to influence school processes and improve student outcomes. The works by Leithwood and colleagues are among the few studies that have explored connections between different sources of leadership and student outcomes (Leithwood and Jantzi 1999, 2000a, 2000b; Leithwood and Mascall 2008). Two of their studies (Leithwood and Jantzi 1999, 2000b) found that principal leadership had significant and indirect effects on survey reports of student engagement, whereas teacher leadership was not related to student engagement. Another study (Leithwood and Jantzi 2000a) found that neither source of leadership had a statistically significant relationship with student engagement once students' family background characteristics were included in the analysis. They did not examine measures of student achievement. Our work builds on this limited research base, studying the ways in which principal and teacher leadership influence student learning, and examines whether principals' influence on school processes and student learning occurs mainly through teacher leadership, independently, or through both pathways.

Besides knowing whether teacher leadership plays a significant mediating role in the relationship between principal leadership and student learning, it is also important to understand how principal and teacher leadership connects to student learning. It is well established that school leaders have mostly indirect effects on student outcomes, but there is less clarity on what the critical mediating processes are and how they matter for student achievement. Often, studies have focused on a single mediating process or on an overall combined measure of school organizational capacity that includes multiple processes. For example, Hallinger and Heck (2010b; Heck and Hallinger 2009, 2010) used a

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measure of academic capacity as the central mediating variable linking school leadership and student outcomes.[1] Leithwood and Jantzi (1999, 2000a, 2000b) also focused on an overall measure of school conditions that included school culture, structure and organization, purposes and goals, and the quality of information used for decision making. Thus, although the studies by Leithwood and Jantzi did separate teacher and principal leadership, their mediational models did not distinguish how leadership linked to student outcomes via specific aspects of school organization versus measures of overall school conditions.

A few studies have examined the importance of isolated aspects of school organization, such as the professional community among teachers, as the main mediating variable in the relationship between school leadership and student learning (Dumay et al. 2013; Louis, Leithwood, et al. 2010; Supovitz 2013; Supovitz et al. 2010). Studies that have simultaneously considered multiple and distinct mediating processes are relatively rare. Bryk et al. (2010) examined the professional capacity of staff, parent and community ties, and the school learning climate as mediators of leadership with instruction and learning and found that schools strong in multiple processes were several times more likely to achieve school improvement than schools weak in any one component. Sebastian and Allensworth (2012) compared the indirect leadership effects from high school principals to student learning via the same mediators as Bryk et al. (2010) and found that only the school's learning climate was a significant mediator in the relationship between leadership and achievement at the high school level. Overall, there is little research that captures the interplay between principal and teacher leadership and key organizational factors as they together link to instruction and learning.

Research Questions

Our study examines principal and teacher leadership as separate, but connected, sources of leadership. The aim of this study is to understand whether, and how, principals may use teacher leadership as a mediating influence to build the capacity of the school to improve student achievement through school organizational processes as mediating factors.

RQ1: Does teacher leadership mediate the relationship between principal leadership and student achievement?

RQ2: What are the mediating organizational processes through which principal leadership is related to student achievement, via teacher leadership, and independent of teacher leadership?

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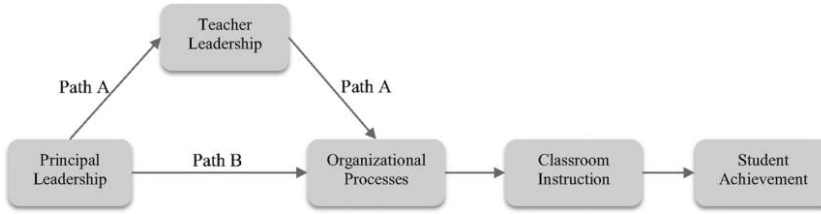

FIG. 1.—Pathways from principal leadership to student achievement

Figure 1 illustrates the first research question and differentiates the indirect pathways from principal leadership to student achievement that include teacher leadership (A) from the direct pathways that are independent of teacher leadership (B).

Conceptual Framework

We adapt the framework of the five essential supports proposed by Bryk et al. (2010), described in figure 2, to examine pathways from school leadership to school organizational processes and student outcomes. Essentially, this framework conceives of school leadership as a prime mover of school improvement that indirectly influences classroom instruction and student learning through multiple organizational processes: professional capacity, learning climate, and parent community ties. The school's contextual conditions, such as the socioeconomic and demographic background characteristics of students, in turn influence all aspects of the school, including leadership, organizational processes, classroom instruction, and student learning, and the relationships between them.

Previous research using this framework has focused on principal leadership or combined both principal and teacher leadership (e.g., Bryk et al. 2010; Sebastian and Allensworth 2012), and we adapt this framework by separating principal and teacher leadership (see figs. 2 and 3) and specifying a directional relationship from principal to teacher leadership. In this conceptualization, part of teacher leadership is a consequence of principal leadership. Principals work to improve school processes, classroom instruction, and student learning in many ways. They delegate responsibility and empower teachers who in turn influence organizational structures, instruction, and learning. They also work directly, independently of teachers, to improve the same school processes, and instruction and learning. For example, to improve parent and community ties, principals

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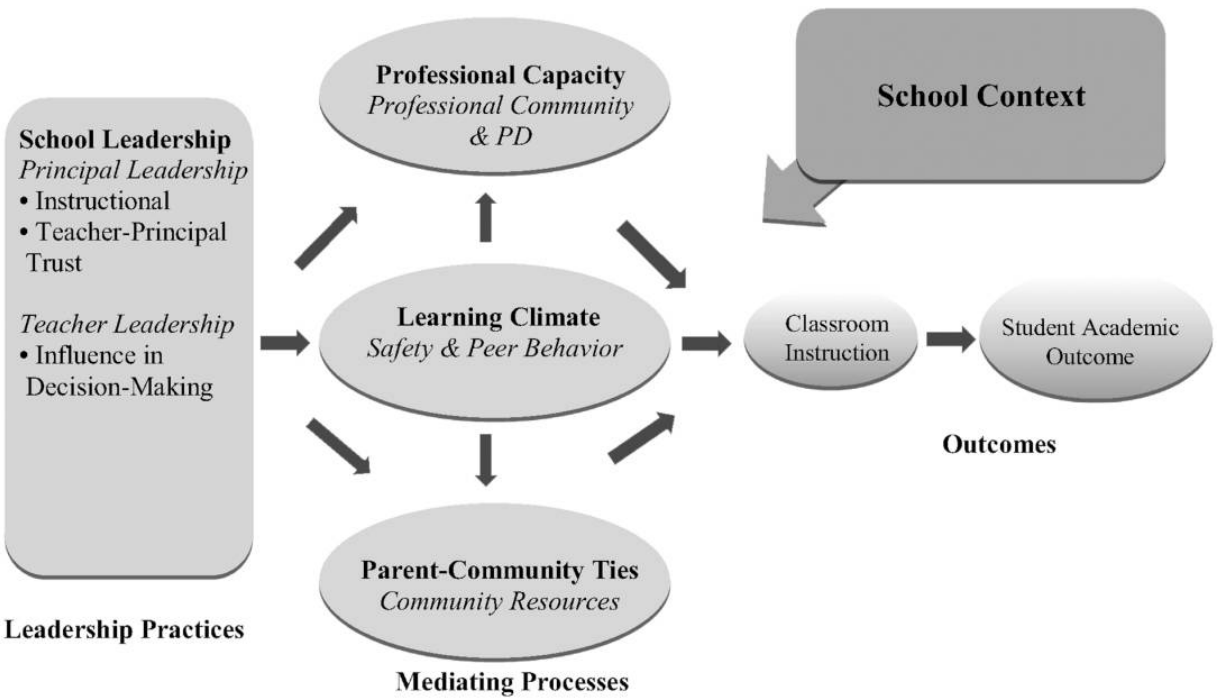

FIG. 2.—Conceptual model, five essential supports. School context influences leadership practices, mediating processes, and outcomes. PD = professional development. Source: Bryk et al. (2010).

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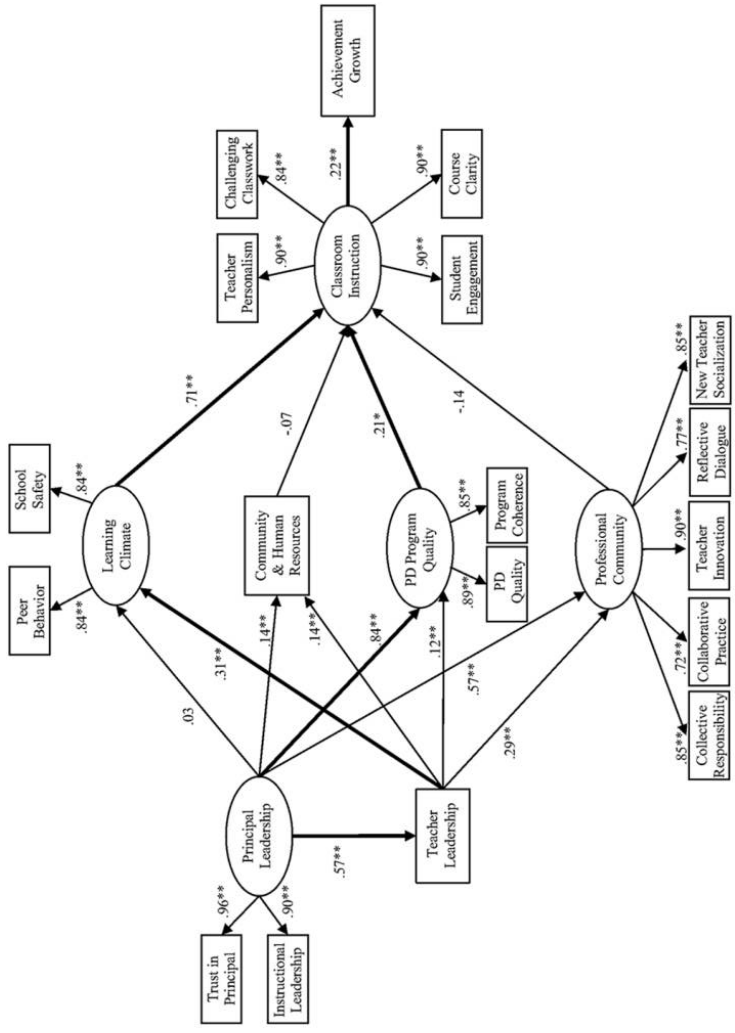

FIG. 3.—Analytical model and results. Bold lines indicate the significant pathways from principal leadership to student achievement growth. PD = professional development. * $p < .05$. ** $p < .01$.

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may delegate responsibility to a few teacher leaders or broadly to all faculty members and task them with developing school capacity to reach out to parents and the community. Alternately, they might meet directly with parents and stakeholders in the community to achieve the same ends. Typically, principals are likely to engage in both modes of improving parent and community ties, working indirectly at times via faculty and at other times directly engaging with parents and community members.

The Bryk et al. (2010) framework can be composed of four main parts: leadership activities, mediating school processes, teaching and learning outcomes, and school contextual factors. Detailed descriptions of the five essentials framework, its different components, and their inter-relationships, have been explored in prior studies (Bryk et al. 2010; Sebastian and Allensworth 2012; Sebastian et al. 2014). We capture principal leadership with two measures—instructional leadership and teacher-principal trust.

One perspective of principal instructional leadership maintains that principals should be directly involved with instruction and be familiar with content and pedagogy (Stein and D'Amico 2000; Stein and Nelson 2003). However, much of the literature on instructional leadership focuses on the role of principals in indirectly supporting teachers in instruction and promoting a learning climate conducive to student learning. Our measure of instructional leadership captures this indirect role and is consistent with the definition of instructional leadership proposed by Supovitz et al. (2010)—setting the school vision, promoting trust and collaboration, and supporting good instructional practices. Our measure of principal leadership is also informed by the degree of trust between the principal and teachers to emphasize an atmosphere of collegiality that goes beyond peer relationships. Prior work with these measures of instructional leadership and principal-teacher trust has shown that they are strongly related and capture one latent measure that we label *principal leadership* (Sebastian and Allensworth 2012). We capture teacher leadership through a measure of teachers' influence over school policy and organization, such as hiring, budget, professional development, and student behavior (see app. A). The extent to which teachers participate in a professional community by assuming collective responsibility for students, collaborating with peers, engaging in reflective dialogue about instruction, and engaging in networks can also be considered a measure of teacher leadership (see, e.g., Supovitz et al. 2010). The Bryk et al. (2010) framework considers professional community to be a key mediator, and therefore we include it not under school leadership variables but as one of the factors that link school leadership to instruction and learning.

The key mediating processes in the Bryk et al. (2010) framework are the professional capacity of staff, parent and community ties, and the school learning climate. The professional capacity of staff includes the extent to which teachers are part of a professional community and the quality of professional de-

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velopment at the school. The three central mediators in turn influence the quality of classroom instruction in the school, which ultimately influences student learning outcomes. Using this framework to examine elementary schools longitudinally, Bryk et al. (2010) found that schools strong in multiple processes were several times more likely to achieve school improvement than schools weak on any one component.

In terms of outcomes, empirical studies of school leadership have often focused on standardized test scores, gains in test scores (Bryk et al. 2010; Heck and Hallinger 2009, 2010; Supovitz et al. 2010), or student grades (Sebastian and Allensworth 2012). A few leadership studies have examined aspects of classroom instruction such as student engagement and classroom participation as the main outcomes of interest (Leithwood and Jantzi 1999, 2000b). However, the quality of classroom instruction can be considered both an outcome in itself and an additional mediational process that influences student achievement. Although classroom instruction could be the most important or proximal determinant of student learning (Cohen and Ball 1999; Raudenbush 2008), most empirical studies on leadership consider instruction as important to their theoretical frameworks but do not directly measure or include it in their analytical models. We included a measure of classroom instruction with multiple aspects that have been shown to be important for learning—academic challenge, student engagement, teacher support, and course clarity (Sebastian and Allensworth 2012; Sebastian et al. 2014). More detailed descriptions of these measures are provided in the next section.

Using the Bryk et al. (2010) conceptual framework, we build on the emerging research that separates the leadership roles of principals and teachers while simultaneously examining their indirect pathways to student outcomes. We focus on student achievement as the main outcome, which we measure as growth on standardized tests by elementary school students as they progress from third to eighth grade. We examine the professional capacity of staff, school learning climate, and parent and community outreach efforts as key organizational processes, or mediators, that link principal and teacher leadership to classroom instruction and student learning. Note that we use longitudinal information only to capture change in the outcome—student growth on standardized tests. We averaged the longitudinal information on leadership, school organizational variables, and classroom instruction to estimate how mean levels of these constructs relate to student achievement growth. The aim of this study is to examine average conditions of school leadership, mediating organizational processes, and instruction that lead to student achievement growth over time. We will eventually seek to tie change in leadership and school organizational variables to student achievement growth in a subsequent study, but doing so greatly increases the modeling complexity and is beyond the scope of this analysis. This study is a first step in understanding these complex relationships.

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Method

Data Sources

To examine how leadership systems relate to student achievement gains, we used data on school leadership, organizational processes, and classroom instruction obtained from surveys of teachers and students. Our main outcome was student achievement gains made on standardized tests by elementary school students in Chicago Public Schools (CPS) as they moved from third to eighth grades between 2006–7 and 2012–13. We matched these data to information from teacher and student surveys administered in 2006–7, 2008–9, 2011–12, and 2012–13 to all CPS elementary schools. An additional point of available survey information in 2010–11 was not used because of the unusually low response rates that year for both students and teachers (see table 1). That was the first year that the survey results were made public in CPS; before then the information was not publicly available. This change in survey administration could have resulted in the drop in response rates for that year, but response rates did improve in subsequent survey years. Elementary schools in CPS are schools serving any combination of grades 3 through 8 (e.g., K–8 schools, middle schools

TABLE 1

Number of Students and Teachers Providing Survey and Test Score Information

Year	Student Survey	Teacher Survey	Student Achievement (ISAT Gain)
2006–7:			
N	72,953	12,181	155,322
N-schools	458	465	492
Response rate (%)	96	93	. . .
2008–9:			
N	63,536	9,119	167,543
N-schools	444	444	495
Response rate (%)	71	84	. . .
2011–12:			
N	60,355	9,165	162,980
N-schools	459	507	509
Response rate (%)	95	92	. . .
2012–13:			
N	64,631	12,263	151,945
N-schools	478	510	464
Response rate (%)	86	83	. . .

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serving grades 6–8). Survey information from different years was aggregated to obtain school-specific averages across the multiple survey administrations.

The surveys were administered by the University of Chicago Consortium on Chicago School Research (the consortium) to all teachers and students in grades 6 and higher in CPS. Most of the school leadership and school organization information for this study relied on information from the teacher surveys. Student surveys provided information on certain aspects of school climate and classroom instruction. Table 1 gives an overview of the numbers of students and teachers in each wave that provided survey information and test score information.

Analytical Technique

The methods used to study school organizations need to reflect sophisticated designs that seek to clarify the complex linkages between leadership and learning (Hallinger and Heck 1996a, 1996b; Leithwood and Jantzi 2000b). Several leadership studies have used structural equation modeling (SEM) to simultaneously test multiple direct and indirect relationships specified in a theoretical model that links leadership to student learning. Our study also used SEM to compare the indirect pathways from principal leadership to organizational processes and student achievement gains (see fig. 3). The analysis was done at the school level on a sample of 534 CPS elementary schools. Each variable in the final SEM model was obtained from empirical Bayes (EB) residuals of hierarchical linear models (HLM) where the outcome variable was regressed on school contextual variables. This allowed us to control for multiple contextual characteristics prior to the actual SEM analysis. Because we have multiple nesting structures—teachers nested within schools for teacher survey data and students nested within schools for student survey and achievement data—we could not use a multilevel SEM framework for our analysis, as it was not possible to combine the teacher- and student-level information in a direct way. Since most of the teacher surveys were also anonymous, the relationships of teacher survey information with student achievement could be examined only at the school level. The SEM model (see fig. 3) was analyzed using the software Mplus 7.11 (Muthén and Muthén 2013) using maximum likelihood (ML) estimation.

In our final SEM model, we simultaneously estimated the multiple relationships specified between school leadership, mediating organizational processes, classroom instruction, and student achievement growth (fig. 3). The relationship of leadership measures with instruction and achievement was specified to be indirect based on a wealth of prior research on leadership that supports only indirect effects of leadership (Hallinger and Heck 1996a, 1996b, 1998). Another important aspect of our main SEM model was that school organizational processes were specified to be related to student achievement only via the qual-

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ity of classroom instruction. Given that the student survey measures used to capture classroom instruction were limited and may not accurately or completely capture the quality of instruction, for validation purposes, we compared our models to an alternate model with direct relationships from organizational processes to student achievement growth. We also examined one other alternate model that included data from 2010–11, the year with low response rates.

Dependent Variable

The dependent variable for this study was student achievement gains on the Illinois Standards Achievement Test (ISAT) in reading and mathematics, which is administered in CPS in the spring of each school year for grades 3 through 8. Data on ISAT gains made by individual students as they moved through these grades were aggregated to the school level using EB residuals from an HLM analysis that predicted student growth in ISAT scores as the outcome. We included repeated observations of ISAT scores of all elementary students that attended CPS between 2007 and 2013 at level 1, nested within individual students at level 2, and schools at level 3 (see app. B). The HLM model also controlled for student demographic characteristics, such as gender, socioeconomic status, ethnicity, age, cohort, and need for special education. At the school level, we controlled for school size and for two indicators of average student socioeconomic status.

Rather than analyzing two separate models for ISAT reading and math achievement, we stacked reading and math scores at level 1 and included a dummy variable to indicate whether the observation was a math test result. We also controlled for whether the student was retained in a certain grade and whether the student had changed schools since a prior observation. The important predictor variable in this model is a linear trend variable at level 1 that captures linear growth across students' multiple ISAT test score observations. The trend variable was allowed to be random at level 2 to capture variation in achievement growth from one student to another. The trend variable was also allowed to be random at level 3, the school level, to capture differences among schools in the average achievement growth made on the ISAT test. From this model, we obtained school-specific estimates (using EB residuals) of the average achievement growth made on the ISAT test between 2007 and 2013 by students of each school as they passed from third to eighth grade. The HLM model did not require all students to have complete ISAT records from third to eighth grade. The maximum likelihood estimation for HLM used available information from all students, even those with missing data points, to provide average estimates of growth. Additional details of this HLM model, including the equations, are provided in appendix B.

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Leadership Variables

We assessed leadership in CPS elementary schools using three measures, two of which were focused on principal leadership and one on teacher leadership. The first measure captured principal instructional leadership from eight questions on areas such as setting school vision and goals and supporting effective classroom instruction. The second measure captured teacher-principal trust from seven questions designed to reflect the extent to which teachers felt that their school principals had confidence in them, had trusting relationships with them, encouraged collaboration, and looked out for their personal welfare. The items in these measures were scaled from 1 = strongly disagree to 4 = strongly agree. Teacher leadership was captured from six questions on the extent of teachers' influence in key school policy matters such as hiring, finance, curriculum, professional development, and school rules on student behavior. The items for teacher influence were measured on scale from 1 = none to 4 = a great extent. All three leadership measures were developed from previous empirical work using Rasch analysis and anchored to have common meaning over multiple survey administrations (Bryk et al. 2010). The specific survey items and the reliabilities of these measures are provided in appendix A. Information on leadership variables were collected from individual teacher surveys, but this information was aggregated to the school level using three separate HLM models (one for each measure). Using the EB residuals of these models, we obtained a weighted school average for each leadership measure from multiple years. The two-level HLM models used for this purpose controlled for survey year, school size, average prior achievement, and average socioeconomic status of students in each school. A description of these HLM models is provided in appendix C.

Mediating Processes

The mediating processes in this study were chosen based on the framework of Bryk et al. (2010) that links leadership and key organizational processes to classroom instruction and student learning. Professional community in the school was captured with five measures: reflective dialogue, new teacher socialization, collective responsibility, collaborative practice, and teacher innovation. The measures together reflect the core concepts of professional community as developed in prior research on school professional communities (Bryk et al. 1999; Kruse et al. 1995). The quality of programs in the school was captured with two measures. The first measure captured the professional development quality in the school and consisted of five items that gauged teacher perceptions

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of how productive, efficient, sustained, and student centered their professional development experiences were in the school year. A second measure consisting of five items measured the extent to which programs in the school were coherent, consistent, coordinated, and sustained. The learning climate in the school was captured with two student survey measures. Student survey information on the behavior of their peers, whether they got along, treated each other with respect, cared about each other, and so on was used to inform one aspect of school climate. A separate measure of student perceptions of school safety captured the extent to which students felt safe inside and around the school buildings. At the high school level, a measure of teachers' expectations of students also inform how the consortium surveys measure the overall learning climate of the school (Bryk et al. 2010). However, this measure was not administered for teachers in elementary schools. The measure of learning climate used for this study, based on safety and student behavior, captures only a limited aspect of school learning climate. Sebastian and Allensworth (2012) found that teacher reports of safety and their expectations for students were strongly correlated; we assumed this would be true for elementary schools as well.

From the student surveys, we used four measures to assess the quality of classroom instruction. Student engagement consisted of five items measuring the extent to which students were interested in their class work, finding it interesting and challenging and not boring. A measure of challenge captured the extent to which the class made students think and pressed students to work hard; this measure consisted of five survey items. Course clarity measured the extent to which students felt that their coursework, expectations, assignments, and tests were clear. A measure labeled teacher personalism (i.e., teacher support) reflected the degree to which teachers supported their students, helping them catch up if they were behind, having high expectations, and providing extra help if needed. The specific survey items for these measures and their reliabilities are provided in appendix A.

As with the leadership measures, individual teacher and student responses were aggregated to the school level using three-level HLMs. From the EB residuals of separate HLMs (one for each survey measure), we obtained school-specific weighted averages on each of these mediating variables. The HLMs controlled for survey year, school size, average prior achievement, and two indicators of the average socioeconomic status of students in the school (see app. C).

Control Variables

Prior school organizational research has shown that the context of the school strongly influences school leadership, mediating processes, classroom instruc-

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tion, and outcomes. In fact, researchers have argued that a comprehensive model of school leadership should include not only organizational processes, connecting them to important student outcomes, but also the influence of the school context (Hallinger and Heck 2010a, 2010b; Heck and Hallinger 2010). However, including the school context in a model linking leadership to student outcomes via multiple mediating factors can be quite complex, as contextual variables theoretically influence all aspects of the school organization and could also moderate their interrelationships. Research examining pathways of leadership to school outcomes via mediating factors typically uses SEM and specifies that school contextual factors predict all variables included in the model. The numerous associations of contextual variables on multiple variables can cause model convergence and model fit issues and can also affect the interpretability of the final solution.

To avoid these problems, we included the influence of school contextual variables in the preliminary HLMs rather than in the final SEM analysis. The EB residuals from HLMs estimating school average student growth on the ISAT and measures of leadership and mediating processes and classroom instruction all control for school contextual variables (see apps. B and C). Four contextual variables were used to control for student achievement growth estimates and for each organizational outcome included in the SEM model. Along with average school size, we used two variables reflecting the average socioeconomic status of students in the school. A standardized measure of poverty created by the consortium was calculated from census data to reflect the percentages of employed adults and of families below the poverty line living in a student's census block. Another standardized measure reflecting social status accounted for the mean level of education of adults and percentage of adults employed as managers or professionals in the student's census block. These student-level variables were averaged to the school level and included in the HLM models. For the models based on survey data, we included a school average measure of prior achievement calculated from the first recorded ISAT scores of students in the sample, standardized by year and grade. Using these contextual variables in estimating weighted averages for each school on leadership, mediating processes, and achievement outcomes via the HLM models meant that they did not have to be entered in the final SEM models, thereby reducing the complexity of the final models and making interpretations easier.

Results

The descriptive statistics for the leadership measures and the measures of mediating organizational processes, classroom instruction, and student achievement growth are provided in table 2. The reported Rasch measures on

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TABLE 2

Descriptive Statistics and Correlation of the Measures

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Instructional leadership	3.40	.62																	
2. Teacher-principal trust	2.28	.56	.87																
3. Teacher leadership	.06	.45	.51	.61															
4. Collective responsibility	3.45	.62	.60	.57	.51														
5. Collaboration practice	.11	.17	.50	.44	.44	.57													
6. Teacher innovation	3.02	.50	.65	.63	.53	.92	.63												
7. Reflective dialogue	.71	.16	.49	.46	.47	.66	.75	.71											
8. New teacher socialization	2.04	.49	.57	.59	.54	.74	.62	.75	.70										
9. PD coherence	.68	.36	.75	.69	.47	.65	.51	.66	.52	.58									
10. PD quality	.98	.33	.78	.70	.57	.60	.57	.63	.56	.62	.76								
11. Achievement growth	13.15	1.69	−.01	.00	.03	.06	.01	.05	−.01	−.03	.02	−.04							
12. Course clarification	2.51	.26	.26	.23	.21	.30	.17	.27	.17	.21	.25	.20	.18						
13. Student engagement	.87	.10	.20	.18	.18	.19	.15	.16	.12	.14	.21	.19	.20	.81					
14. Challenging class work	.52	.08	.23	.17	.14	.25	.14	.24	.14	.16	.18	.15	.22	.84	.76				
15. Teacher personalism	1.17	.16	.19	.17	.17	.24	.15	.23	.13	.19	.17	.16	.18	.85	.80	.77			
16. Community resources	−.01	.14	.21	.21	.22	.21	.19	.18	.17	.21	.21	.24	.05	.40	.45	.35	.38		
17. Peer behavior	−.02	.12	.16	.21	.29	.29	.18	.24	.16	.26	.21	.20	.19	.55	.59	.48	.55	.55	
18. School safety	1.17	.15	.14	.19	.28	.25	.18	.25	.17	.21	.19	.15	.18	.47	.44	.44	.46	.63	.71

NOTE.—PD = professional development.

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leadership and mediating processes are on a 10-point scale that ranges from –5.00 to 5.00.

The final SEM model showed good fit to the data (CFI = 0.96, TLI = 0.95, RMSEA = 0.07, SRMR = 0.03).[2] The results of the final SEM model are reported in tables 3 and 4. Figure 3 also highlights the pathways from principal leadership to student achievement growth that are statistically significant with bold lines. The reported results are standardized and can be read as the expected change in each outcome in standard deviation units when the predictor increases by one standard deviation. The model results show that principal leadership was significantly associated with student achievement growth both directly and indirectly via teacher influence. Table 3 describes the indirect relationships of principal leadership with student achievement growth via teacher leadership and independent of teacher leadership. Among the eight possible paths from principal leadership to student growth, two of them were statistically significant. These two paths were:

- Principal leadership → teacher leadership → learning climate → classroom instruction → student achievement growth, and
- Principal leadership → teacher professional development and program quality → classroom instruction → student achievement growth.

The standardized coefficients of these two paths were 0.03 ($p < .01$) and 0.04 ($p < .05$), respectively.

The first eight rows of table 4 (under "Regression Results") show the relationship of principal and teacher leadership with multiple school organizational processes. Both principal and teacher leadership were related to mediating organizational processes. However, school learning climate—which is the organizational process that is most strongly related to classroom instruction—was only significantly related with principal leadership through teacher leadership.

Principal leadership had strong direct relationships with professional community at 0.57 ($p < .01$) and program quality at 0.84 ($p < .01$), even after teacher leadership was taken into account. Principal leadership was also strongly related to teacher leadership, at 0.57 ($p < .01$), which is consistent with prior research that suggests that these two forms of leadership tend to coexist. Overall, these results suggest that principal leadership is positively associated with key school organizational processes both directly and indirectly via teacher influence.

We ran two variations to the SEM model shown in figure 3. In one alternate specification, we allowed direct pathways from the mediating processes to achievement growth and pathways from leadership to instruction and achievement growth. This model showed poorer fit than the original model according to the TLI (0.94), and RMSEA (0.08), whereas the CFI value was similar (0.96) to the original model. One interesting result of the alternate model was that the

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TABLE 3

SEM Model Results

Principal Leadership							Student Achievement	β	SE
↓		→	Community human and social resources	→	Classroom instruction	→	↑	.00	.00
↓		→	Program quality	→	Classroom instruction	→	↑	.04*	.02
↓		→	Professional community	→	Classroom instruction	→	↑	−.02	.01
↓		→	Learning climate	→	Classroom instruction	→	↑	.01	.01
↓	→	Teacher leadership	Community human and social resources	→	Classroom instruction	→	↑	.00	.00
↓	→	Teacher leadership	Program quality	→	Classroom instruction	→	↑	.00	.00
↓	→	Teacher leadership	Professional community	→	Classroom instruction	→	↑	−.01	.00
↓	→	Teacher leadership	Learning climate	→	Classroom instruction	→	↑	.03*	.01

*$p < .05$.

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TABLE 4

SEM Model Regression Results

Regression Result			Estimate	SE	Est./SE	*p*
Achievement growth	(on)	Classroom instruction	.22	.04	5.06	.00
Classroom instruction	(on)	Learning climate	.71	.06	11.28	.00
Classroom instruction	(on)	Teacher professional development	.21	.09	2.38	.02
Classroom instruction	(on)	Professional community	−.14	.09	−1.53	.13
Classroom instruction	(on)	Community social and human resources	−.07	.06	−1.13	.26
Learning climate	(on)	Principal leadership	.03	.06	.59	.55
Teacher professional development	(on)	Principal leadership	.84	.03	30.31	.00
Professional community	(on)	Principal leadership	.57	.04	14.99	.00
Community social and human resources	(on)	Principal leadership	.14	.05	2.72	.01
Learning climate	(on)	Teacher leadership	.31	.05	5.70	.00
Teacher professional development	(on)	Teacher leadership	.12	.04	3.35	.00
Professional community	(on)	Teacher leadership	.29	.04	7.12	.00
Community social and human resources	(on)	Teacher leadership	.14	.05	2.68	.01
Teacher leadership	(on)	Principal leadership	.57	.03	17.54	.00

quality of classroom instruction was no longer significantly related to student achievement growth. Only the school's learning climate was significantly related to achievement growth, suggesting that the learning climate is the most important variable influencing student learning. In this model, the only significant pathway from principal leadership to student achievement was:

> Principal leadership → teacher leadership → learning climate → student achievement growth (coefficient $= 0.06$; $p < .01$).

The pathway involving school programs and professional development was no longer significant. Results of this model showed a slightly stronger overall influence of leadership on student achievement because it allowed for school organizational factors other than the quality of classroom instruction to directly influence student learning gains. The results of the alternate model give greater confidence that one of the main pathways from principal leadership to student learning is through the influence of teacher leadership on the school learning climate.

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In another model we included survey data from 2010–11 that had low teacher and student survey response rates. The results from this SEM model again showed that only one pathway from principal leadership to student achievement growth was significant: the pathway including teacher leadership and school learning climate. Overall, these model variations confirmed the importance of the school's learning climate as the most important variable in influencing classroom instruction and student achievement growth. Furthermore, it appears that schools with greater teacher influence are also more likely to have stronger school learning climates.

Discussion

Leaders might influence student learning through many paths, but only a few make a significant difference for student achievement growth. If principals neglect one path that has a strong relationship with student achievement in favor of one that has no influence, they may not have much of a total effect. This suggests that the specific mechanisms through which leaders try to influence learning matter considerably. The present study provides clarity about which paths are most influential for student achievement in elementary school and makes several contributions to the field of research on leadership.

First, this study shows that at elementary schools—not just at high schools—one of the main ways in which principals influence student achievement is through school climate. The central mediating organizational process that links both principal and teacher leadership to student achievement is the school learning climate. A substantial body of prior research has examined the importance of school safety for student learning gains (for a review, see Cornell and Mayer 2010). Similarly, the role of schools in influencing student behavior and school safety has also been well studied. Formal and informal discipline rules and policies, responses to student misbehavior, and the use of counseling and intervention strategies are some ways through which the work of principals and teachers can influence school safety and student behavior (Mayer 1995; Osher et al. 2010; Rones and Hoagwood 2000; Swearer et al. 2010; Wilson et al. 2001; Wilson et al. 2003). Our study links these separate strands of research and suggests that the degree to which a school is safe and orderly is the key factor that distinguishes whether schools with strong leadership show high or low learning gains.

Grissom and Loeb (2011) compared principal self-efficacy in various leadership tasks and found that only their skills in organizational management were related to school academic outcomes; school safety was the strongest aspect of their measure of organizational management. Horng et al. (2010) examined

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the time principals spend on various activities and concluded that the time they spend on organizational management was related to achievement outcomes, but the time they spend on instructional activities was not. Bartoletti and Connelly (2013) argue that these findings emphasize the importance of the indirect instructional leadership role of school leaders in providing the supporting conditions for good instruction and student learning. Our findings are consistent with these conclusions and clarify that principals' efforts in establishing positive and safe learning climates are central to their roles as effective instructional leaders.

It is clear from the results of this study that teachers' perceptions of their schools' climates influence how they rate their principals as instructional leaders and the extent to which they trust their principals. One interpretation of the results could be that the measure of principal leadership used in this study that emphasizes instructional leadership may have functioned as a proxy for principals' organizational management skills, which Grissom and Loeb (2011) characterize as managerial skills in running the building. Alternately, the separation of organizational and management skills in research may be disconnected from how principals work in actual settings. Scholars have long argued that both organizational and management skills are part of successful leadership and are components that reinforce each other (Bryk et al. 2010; Grissom and Loeb 2011). From this perspective, teachers' ratings of their principals on instructional leadership take into account principals' abilities to keep schools safe and to promote high expectations for students.

Instructional leadership can be viewed as direct involvement in the classroom—providing feedback on pedagogy, structuring professional development, reviewing lesson plans, going on walk-throughs. However, by fostering a school climate where students and teachers feel safe to do their work of teaching and learning, all classrooms benefit. Prior research has shown this to be the only mechanism through which principal leadership explained between-school differences at the high school level (Sebastian and Allensworth 2012). We assumed that this could be because of the complexity of high schools. With 100 or more teachers teaching many different subjects, it would be impossible for a high school principal to give consistent, strong instructional support to each teacher. Thus, it made sense that most of the leader's influence would come through the school climate. Yet, the current study shows that climate is also one of the key mechanisms for supporting student achievement in elementary schools.

Second, this study shows that in elementary schools, principals' influence on school climate comes almost entirely through teacher influence in decision making. The results of the SEM models suggest that empowering teachers to wield greater influence over school policy matters concerning the school learning

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climate may be the most effective strategy for school principals to improve student achievement. The concept of empowering employees has become popular in organizational studies in recent years (Seibert et al. 2004), and the push for greater teacher leadership has gained traction in school organizational research and policy (Leithwood and Jantzi 2000b; Leithwood and Mascall 2008). In theory, its effectiveness stems from increased motivation at work through the delegation of authority (Seibert et al. 2004). It is also consistent with one of the Carnegie Foundation's six core principles of improvement (Bryk et al. 2015)—that improvement initiatives be codeveloped with the users and should engage key participants early and often. Beyond providing empirical support for the benefits of teacher leadership for student learning, our study also suggests that targeted teacher influence in the area of school learning climate is most effective.

At the same time, this does not mean that effective teacher leadership is independent of principal leadership. A central assumption in the conceptual and analytical model of this study is that principal leadership influences teacher influence. Although this conceptualization is different from that of studies that view both teacher and principal leadership in terms of nonhierarchical and reciprocal interactions (Jackson and Marriott 2012), it is consistent with both theory and research on effective interplay of principal and teacher leadership roles (York-Barr and Duke 2004). For example, Johnson et al. (2014), in a study of teachers in six schools in an urban school district, found that teachers wanted to assume leadership roles but looked to their principals to set direction. They also found that none of the principals in their study approached their roles in a laissez-faire manner and that principals had great influence over teachers' opportunities to participate in school improvement (Johnson et al. 2014). The teachers in their study were interested in participating in leadership roles and did not simply take orders from the principal; at the same time, they recognized the formal authority of the principal. When principals did not empower teachers and limited their leadership capacity, school reforms did not succeed.

There are many different approaches that principals may take to achieve their goals for school improvement and many ways in which they might foster shared leadership. For example, in a series of case studies of school leadership styles, Anderson (2012) contrasts traditional approaches of shared leadership—where leaders initiate programs and assign responsibilities to others—to an approach that fosters collaboration among staff with the school leader acting as a bridge among teachers, teacher trainers, and parents. That work suggested that the collaborative approach was more effective for producing change in instruction. The case studies described by Anderson (2012) compared leadership efforts aimed at curriculum and instruction, but these approaches could also be applied to goals for school climate. For example, a leader taking a

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traditional approach to address school safety might decide to assign particular staff members to oversee school discipline—counselors, a dean of discipline, security guards, social-emotional learning specialists—or might personally work to clarify discipline policies so there is more consistency in enforcement from teachers and staff. In these scenarios, teachers would be recipients of the school's strategies for climate and discipline and might praise them or complain about them but would ultimately view school climate as a problem managed by others. In contrast, a principal taking a collaborative approach might bring teachers and staff together to develop and test strategies for supporting student behavior, connecting them to experts in restorative justice or social-emotional issues and monitoring the effects of their strategies through data on student behavior. In this scenario, teachers would have substantial influence on the design and the implementation of the school goals for school climate rather than relying on others.

Fostering a strong school climate through teacher leadership appears to be the key mediating mechanism through which leadership is related to student achievement, and a second mediating process through which elementary school principals influence student achievement is through the quality and coherence of programs offered in the school—professional development, curriculum, and instruction. It appears that principals' direct involvement in these areas, rather than indirect influence via teachers, translates to benefits for student learning. The quality and coherence of programs offered at the school, along with professional development opportunities, cut across multiple grade levels, subject specializations, and academic departments. The principal might be the best person to directly oversee all school programs and professional development opportunities so they are aligned, sustained, and consistent with the goals of the school.

Limitations and Directions for Future Research

This study has a number of limitations that suggest directions for future research. Most research studies on leadership have focused on administrators and teachers, although parents, students, and community members also have the potential to exercise leadership. Measuring the influence of parents, students, and other important stakeholders using a measure similar to that for teacher influence used in this study is a potential next step in considering effective pathways from school leaders to student outcomes. Another limitation of this study relates to the measurement of classroom instruction. The moderate association of our measures of classroom instruction with student learning gains suggests that other elements of instruction are missing from the model.

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In particular, survey information on levels of classroom control and student disruption, which have been shown to be important factors at the high school level (Sebastian and Allensworth 2012), was not available to us when studying elementary schools and is one aspect of instruction not captured in our survey measures. Also, as mentioned earlier, our measure of school learning climate is based only on school safety and student behavior. Based on research using the consortium surveys in high schools (Sebastian and Allensworth 2012) that measured climate more broadly, a critical assumption we make in this study is that if measures such as teachers' expectations of students were indeed available, they would correlate highly with our school safety and student behavior measures.

Although our study does control for school contextual information such as average socioeconomic status of students and school size, several potentially important variables such as principal and teacher turnover, principal and teacher tenure, and student attrition were not accounted for. Spillane and Lee (2014) argue that first-year principals experience a "reality shock" that influences their leadership practice; therefore, principal experience is a particularly important variable that we were not able to include in our study. We also were not able to model the role of assistant principals, department heads, and other formal leadership positions outside the principal's office. The interplay of formal and informal roles in determining effective school leadership is another complexity of school organizations that we were not able to include.

Researchers have argued that the scarcity of studies that make use of longitudinal data has hampered our understanding of school leadership (Dumay et al. 2013; Hallinger and Heck 2009, 2010a, 2010b; Heck and Hallinger 2010). Capturing change with longitudinal information considerably increases the analytical sophistication and computational requirements for estimating relationships between leadership and school outcomes. Longitudinal extensions of the present study would need to account for present and past status and for change over time on multiple measures of leadership, organizational processes, school outcomes, and contexts (Heck and Hallinger 2010). For example, we interpret our SEM results as suggesting that principals should empower teachers in the area of school safety and student behavior to be effective leaders. However, our results are based on cross-sectional measures of teacher influence, whereas empowerment indicates a change or increase in teacher influence. Therefore, a next step to this study would involve modeling both prior teacher influence and change in teacher influence over time to examine the benefits of teacher empowerment.

Longitudinal models linking leadership, school organization, instruction, and learning would require the use of sophisticated modeling techniques that are not also overwhelmingly complex. Most leadership studies tend to be cross-sectional, and longitudinal models typically use simpler conceptual models with a

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single leadership measure and one or two mediators (e.g., Dumay et al. 2013; Hallinger and Heck 2010a; Heck and Hallinger 2009). Combining longitudinal information with a comprehensive conceptual model linking school leadership to student learning requires the use of innovative methods such latent transition analysis (Nylund 2007) and growth-mixture models (Muthén and Muthén 2000). The present study is a first step toward that goal and serves as a foundation for developing more complex dynamic models examining school organizational change in relation to school improvement.

The findings presented here do not mean that only learning climate, program quality, and professional development matter as mediating organizational processes for school effectiveness, simply that those are the strongest pathways. The "net effects approach" (Ragin 2008) inherent in our SEM analysis estimates the importance of each pathway linking leadership and student achievement, controlling for all other pathways. Sebastian et al. (2014) showed that if we instead examine the importance of combinations of organizational factors as they relate to school outcomes, multiple mediating organizational processes from the Bryk et al. (2010) framework can produce different levels of key school outcomes (e.g., very strong instruction versus strong instruction versus weak instruction), with different outcomes possible based on the context of the school (e.g., the student body composition). From that perspective, each organizational process may be necessary but not sufficient on its own to influence school outcomes, and combinations of multiple processes may be required for school improvement. However, net effects methods (i.e., methods that estimate the importance of one factor net of everything else), such as regression and SEM, can help us understand the relative importance of effective pathways from leadership to student learning in comparison to one another, which was a goal of this study.

A final limitation is that these analyses do not allow for strong causal inference. This analysis has provided insight into the strongest paths through which principals are likely to influence instruction and student achievement; these could subsequently inform the structure of training programs for leadership development. However, it does not provide evidence that principals will be more effective if they receive such training. Further steps would be to design training programs or supports in these areas and to compare the effectiveness of principals who get training or support in these areas, or to compare the effects of training programs with different areas of emphasis.

In summary, this article adds to the limited evidence of how principal and teacher leadership interact in influencing school organizational structures and, ultimately, classroom instruction and student learning. We find that the school learning climate is the most important factor linking principal leadership and student achievement growth. Furthermore, this relationship is completely mediated through teachers' influence in decision-making processes. The quality of programs in the school—how coherent various programs are and what quality

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professional development has—also directly links principal leadership with student achievement. As the findings related to program quality were not robust to certain validity checks, the strongest implication for policy and practice from this study pertains to the leaders' work in improving school climate and the importance of sharing this work with teacher leaders.

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Appendix A

Survey Measures and Corresponding Items

Measure	Reliability	ICC	Survey Item	Answer Value
Leadership:				
Principal instructional leadership	.79	.16	The principal at this school: 1. Makes clear to the staff his or her expectations for meeting instructional goals; 2. Communicates a clear vision for our school; 3. Understands how children learn; 4. Sets high standards for student learning; 5. Presses teachers to implement what they have learned in professional development; 6. Carefully tracks student academic progress; 7. Knows what's going on in my classroom; 8. Participates in instructional planning with teams of teachers	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Teacher-principal trust	.84	.22	Please mark the extent to which you disagree or agree with each of the following: 1. The principal has confidence in the expertise of the teachers; 2. I trust the principal at his or her word; 3. It is okay in this school to discuss feelings, worries, and frustrations with the principal; 4. The principal takes a personal interest in the professional development of teachers; 5. The principal looks out for the personal welfare of the faculty members; 6. The principal places the needs of children ahead of personal and political interests; 7. The principal at this school is an effective manager who makes the school run smoothly	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Teacher leadership	.85	.26	How much influence do teachers have over school policy in each of the areas below: 1. Hiring new professional personnel; 2. Planning how discretionary school funds should be used;	1. None; 2. A little; 3. Some; 4. To a great extent

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(*Continued*)

Measure	Reliability	ICC	Survey Item	Answer Value
			3. Determining books and other instructional materials used in classrooms; 4. Establishing the curriculum and instructional program; 5. Determining the content of in-service programs; 6. Setting standards for student behavior	
Professional community:				
Collective responsibility	.78	.16	How many teachers in this school: 1. Help maintain discipline in the entire school, not just their classroom; 2. Take responsibility for improving the school; 3. Feel responsible to help each other do their best; 4. Feel responsible that all students learn; 5. Feel responsible for helping students develop self-control; 6. Feel responsible when students in this school fail	1. None; 2. Some; 3. About half; 4. Most
Collaborative practice	.74	.18	This school year, how often have you: 1. Observed another teacher's classroom to offer feedback; 2 Observed another teacher's classroom to get ideas for your own instruction; 3. Gone over student assessment data with other teachers to make instructional decisions; 4. Worked with other teachers to develop materials or activities for particular classes; 5. Worked on instructional strategies with other teachers	1. Never; 2. Once or twice; 3. 3 to 9 times; 4. 10 or more times
Teacher innovation	.76	.16	How many teachers in this school: 1. Are really trying to improve their teaching; 2. Are willing to take risks to make this school better; 3. Are eager to try new ideas.4. All teachers are encouraged to "stretch" and "grow"; 5. In this school, teachers are continually learning and seeking new ideas	1. None; 2. Some; 3. About half; 4. Most 1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree

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Reflective dialogue	.66	.17	1. Teachers talk about instruction in the teachers' lounge, faculty meetings, etc.; 2. Teachers in this school share and discuss student work with other teachers	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
			This school year, how often have you had conversations with colleagues about: 3. What helps students learn the best; 4. Development of new curriculum; 5. The goals of this school; 6. Managing classroom behavior	1. Less than once a month; 2. 2 or 3 times a month; 3. Once or twice a week; 4. Almost daily
New teacher socialization	.71	.14	1. Experienced teachers invite new teachers into their rooms to observe, give feedback, etc.; 2. A conscious effort is made by faculty to make new teachers feel welcome here	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Community human and social resource:				
Human and social resource	.95	.25	1. Adults in this neighborhood know who the local children are; 2. During the day, it is safe for children to play in the local park or playground; 3. People in this neighborhood can be trusted; 4. There are adults in this neighborhood that children can look up to; 5. The equipment and buildings in the neighborhood, park, or playground are well kept	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Quality of programs:				
Professional development quality	.79	.18	Overall, my professional development experiences this year have: 1. Been sustained and coherently focused, rather than short-term and unrelated; 2. Included enough time to think carefully about, try, and evaluate new ideas; 3. Been closely connected to my school's improvement plan; 4. Included opportunities to work productively with colleagues in my school; 5. Included opportunities to work productively with teachers from other schools	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree

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(*Continued*)

Measure	Reliability	ICC	Survey Item	Answer Value
Program coherence	.82	.23	1. Once we start a new program, we follow up to make sure that it's working; 2. We have so many different programs in this school that I can't keep track of them all; 3. Many special programs come and go at this school; 4. Curriculum, instruction, and learning materials are well coordinated across the different grade levels at this school; 5. There is consistency in curriculum, instruction, and learning materials among teachers in the same grade level at this school	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Learning climate:				
Behavior of peers	.93	.27	1. Most students in my school don't really care about each other; 2. Most students in my school like to put others down; 3. Most students in my school help each other learn; 4. Most students in my school don't get along together very well; 5. Most students in my school just look out for themselves; 6. Most students in my school treat each other with respect	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
School safety	.94	.22	How safe do you feel: 1. Outside around the school; 2. Traveling between home and school; 3. In the hallways and bathrooms of the school; 4. In your classes	1. Not safe; 2. Somewhat safe; 3. Mostly safe; 4. Very safe
Quality of classroom instruction:				
Course clarity	.88	.08	1. I learn a lot from feedback on my work; 2. It's clear to me what I need to do to get a good grade; 3. The work we do in class is good preparation for the test; 4. The homework assignments help me to learn the course material; 5. I know what my teacher wants me to learn in this class	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree

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Student engagement	.91	.16	1. I usually look forward to this class; 2. I work hard to do my best in this class; 3. Sometimes I get so interested in my work I don't want to stop; 4. The topics we are studying are interesting and challenging	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
Challenging class work	.91	.14	How often do your students do the following: 1. This class really makes me think; 2. I'm really learning a lot in this class; 3. Expects everyone to work hard; 4. Expects me to do my best all the time; 5. Wants us to become better thinkers, not just memorize things	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree
			In your class, how often: 6. Are you challenged? 7. Do you have to work hard to do well? 8. Does the teacher ask difficult questions on tests? 9. Does the teacher ask difficult questions in class?	1. Never; 2. Once in a while; 3. Most of the time; 4. All of the time
Teacher personalism	.90	.11	The teacher for this class: 1. Helps me catch up if I am behind; 2. Is willing to give extra help on schoolwork if I need it; 3. Notices if I have trouble learning something; 4. Gives me specific suggestions about how I can improve my work in this class; 5. Explains things in a different way if I don't understand something in class	1. Strongly disagree; 2. Disagree; 3. Agree; 4. Strongly agree

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Appendix B

Empirical Bayes Residuals of Student Achievement Using HLM

We use a three-level hierarchical linear model to estimate ISAT growth—years (level 1) are nested within students (level 2), and students are nested within schools (level 3).

Level 1:

$$Y_{ijk} = \pi_{0jk} + \pi_{1jk}(\text{trend}_{ijk}) + \sum_{n=2}^{N} \pi_{njk}(X)_{ijk} + e_{ijk}, \tag{B1}$$

where Y denotes achievement growth in ISAT from 2006–7 to 2012–13; π_{0jk} is the level 1 intercept; trend is a variable tracking year of the test with π_{1jk} as its coefficient; $\boldsymbol{X}$ represents the level 1 control variables, including subject (mathematics as a dummy variable), retention, and school change (whether school transfer occurred); and π_{njk} is the corresponding coefficient for $\boldsymbol{X}$. We let the level 1 intercept and the slope of the trend variable vary randomly for level 2.

Level 2:

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(\text{cohort}_{jk}) + \sum_{m=2}^{M} \beta_{0mk}(W)_{0jk} + r_{0jk}, \tag{B2}$$

$$\pi_{1jk} = \beta_{10k} + \beta_{11k}(\text{cohort}_{jk}) + \sum_{m=2}^{M} \beta_{1mk}(W)_{1jk} + r_{1jk}. \tag{B3}$$

At level 2, we control for cohort year, socioeconomic status, concentration of poverty, special education needs, age, race, gender, grade, and prior reading achievement to predict both π_{0jk} and π_{1jk}. These control variables are denoted as $\boldsymbol{W}$.

Level 3:

$$\beta_{00k} = \gamma_{000} + \sum_{p=1}^{P} \gamma_{00p}(Z)_{00k} + \mu_{00k}, \tag{B4}$$

$$\beta_{01k} = \gamma_{010} + \sum_{p=1}^{P} \gamma_{01p}(Z)_{01k} + \mu_{01k}, \tag{B5}$$

$$\beta_{10k} = \gamma_{100} + \sum_{p=1}^{P} \gamma_{10p}(Z)_{10k} + \mu_{10k}, \tag{B6}$$

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$$\beta_{11k} = \gamma_{110} + \sum_{p=1}^{P} \gamma_{11p}(\mathcal{Z})_{11k} + \mu_{11k}, \tag{B7}$$

where $\mathcal{Z}$ represents the school level contextual variables including school size, socioeconomic status, and concentration of poverty, controlled at level 3, the school level. In addition, all control variables, except trend and cohort, are centered on the grand mean.

Appendix C

Empirical Bayes Residuals of Survey Measures Using HLM

Leadership measures, including instructional leadership, teacher leadership, and all the mediating measures, are estimated with the same model with no control variables at level 1:

Level 1:

$$Y_{ijk} = \pi_{0jk} + e_{ijk}. \tag{C1}$$

Next, we control the year (2008–9, 2011–12, and 2012–13) of survey measures at level 2:

Level 2:

$$\pi_{0jk} = \beta_{00k} + \sum_{m=1}^{M} \beta_{0mk}(\text{year})_{0jk} + r_{0jk}. \tag{C2}$$

At level 3, we control school size, school average socioeconomic status, concentration of poverty, and prior achievement, all denoted as $\mathcal{Z}$. Also these level 3 control variables are centered on the grand mean.

Level 3:

$$\beta_{00k} = \gamma_{000} + \sum_{p=1}^{P} \gamma_{00p}(\mathcal{Z})_{00k} + \mu_{00k}. \tag{C3}$$

Notes

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1. Academic capacity is a school organizational factor defined broadly to include an emphasis on standards, focused sustained action on improvement, high quality student support, and the professional capacity of the school (Hallinger and Heck 2010b).

2. Values of more than 0.95 for the confirmatory factor analysis (CFI) and Tucker-Lewis index (TLI) are considered to indicate good model fit (Hu and Bentler 1999). For the root mean square error of approximation (RMSEA), values less than 0.06 (Hu and Bentler 1999), or less than an upper limit of 0.07 (Steiger 2007) are considered to indicate good fit. For the standardized root mean square residual (SRMR), values less than 0.08 are considered to indicate acceptable fit, whereas a value of 0.00 indicates perfect fit (Hu and Bentler 1999). The SRMR tends to be lower when there are more parameters to estimate, as is the case in this study.

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