

How Principals and Peers Influence Teaching and Learning

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Abstract

This paper examines the effects of principal leadership and peer teacher influence on teachers' instructional practice and student learning. Using teacher survey and student achievement data from a mid-sized urban southeastern school district in the United States in 2006–2007, the study employs multilevel structural equation modeling to examine the structural relationships between student learning and theorized dimensions of principal leadership, teacher peer influence, and change in teachers' instructional practice. The findings confirm previous empirical work and provide new contributions to research on the chain of hypothesized relationships between leadership practice and student learning. Both principal leadership and teacher peer influence were significantly associated with teachers' instructional practices and English language arts (ELA) student learning. A major contribution of this research is the strong and significant indirect relationships which mediate education leadership and student learning. The results indicate the importance of principals work for student learning because of their indirect influence on teachers' practices through the fostering of collaboration and communication around instruction.

Keywords

leadership impacts, distributed leadership, instructional improvement, student learning, multilevel structural modeling

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The literature on the effects of school leadership on student learning stretches back for at least 40 years. The accumulation of that literature suggests that although principals can have a detectable effect on student performance, their effects are mostly mediated through other aspects of school life that influence what and how teachers teach in classrooms. More recent explorations of leadership have incorporated a range of other leadership activities in schools—mostly leadership enacted by teachers and other “informal” school leaders—that influence instructional practice.

In this study we combine these two trends and examine the effects of both principal leadership and peer influence on teachers’ instructional practice and student learning. Using a data set collected from a school district in the southeastern United States that allows us to connect teachers’ survey data to students’ learning outcomes, we are able to examine the relationships between both teacher perceptions of principal practice as well as peer influence on student learning, as mediated by instructional practice.

We find that both leadership practice and peer influence are related to teacher instructional practice, which, in our data set, is significantly related to English language arts (ELA) achievement but not mathematics achievement. Furthermore, teacher reports of peer influence had an equivalent influence in ELA and a 2 times greater impact in mathematics on teachers’ practice than do teacher reports of principal leadership activity. However, principal leadership also influences instructional practice indirectly by significantly affecting how teachers report the influence of their peers.

Literature Review

Principal Leadership and Its Effects on Student Achievement

There have been several thorough reviews of the literature on the relationship between school leadership—mostly defined as the efforts and activities of school principals—and student outcomes. Hallinger and Heck (1998) synthesized 43 studies conducted between 1980 and 1995 that investigated evidence of the relationship between principal leadership and student achievement. They organized the studies into three categories: direct effects of leadership practice on student outcomes; mediated effects studies, in which principal leadership was mediated by other people, events, or organizational factors; and reciprocal effect studies, in which the relationships between leadership efforts and school and environmental factors were interactive. The authors saw little evidence of direct effects and few examples of reciprocal effects studies, with most evidence pointing to indirect effects. They concluded that principals have a measurable, but indirect, effect on school effectiveness and student achievement.

A second synthesis of the literature on the relationship between school leadership practices and student outcomes was conducted by Waters, Marzano, and McNulty (2003), who synthesized 70 research studies relating principal leadership to student achievement that were conducted from the early 1970s through the early 2000s. The studies they examined looked at a wide array of leadership responsibilities, including a focus on school culture, faculty motivation, instructional support, and emphasis on accountability. They produced effects sizes for each of the different dimensions of leadership that were examined. Across these disparate studies, they found an average effect size of .25 and concluded that “there is, in fact, a substantial relationship between leadership and student achievement” (p. 3).

Witziers, Bosker, and Kruger (2003) conducted a quantitative meta-analysis of studies that looked at the overall effects of school leadership on student learning as well as studies that examined the impact of specific principal behaviors on student outcomes. They found small direct effects across studies of elementary school principal leadership but no detectable direct impacts of secondary school principal leadership. They found larger effects, although with more variability, in studies of more specific leadership behaviors.

A more holistic analysis of a wide range of leadership literature was conducted by Leithwood, Seashore Louis, Anderson, and Wahlstrom (2004). They developed a conceptual model of how leadership at different levels of the education system (state, district, other stakeholders) influenced school leadership, which interacted with school and student conditions to produce student outcomes. Through a synthesis of both the quantitative and qualitative studies of these factors, they concluded that school leadership “is second only to teaching among school-related factors in its impact on student learning” (p. 5).

One particular empirical study of principal leadership was particularly relevant to our work, because of both its focus and the methods it employed. Hallinger, Bickman, and Davis (1996) examined the relationship between principal leadership and student reading achievement using structural equation modeling (SEM). SEM allowed them to simultaneously test the independent effects of multiple antecedent and intervening variables. They found no direct effects between indicators of principal leadership and student performance. They then explored the ways that school and classroom variables mediated the relationship between principal leadership and student achievement. They found that principal leadership significantly predicted variables of instructional climate and instructional organization and that those variables were positively and significantly related to student achievement.

In summary, the accumulated literature on the relationship between principal practice and student learning indicates two things. First is a confirmation that principals can have a detectable effect on student learning outcomes. And

second, these effects are more likely to be mediated by other school and classroom factors than directly by principal actions. This leads to two questions: What are the key activities of principals that produce changes in classrooms and students' performance? And what are the contributions of other school factors to student improvement?

Key Activities of School Principals

Underneath more global findings of principal support for improved instructional practice and student learning are a myriad of explorations of what, more precisely, principals do to produce these outcomes. In their systematic review of the literature, Waters et al. (2003) provided a list of more than 20 leadership activities that they found were statistically related to student learning. These included such diverse activities as setting maintaining order and discipline; fostering shared belief and cooperative community; securing resources; involvement in the design and implementation of curriculum, instruction, and assessment practices; monitoring the effectiveness of school practices; and recognizing and awarding accomplishments.

To make matters more complex, context is also acknowledged to play an important role in identifying the essential activities of school leadership. As Hallinger et al. (1996) observe, "The task of unraveling the effects of administrative practices on student learning has been complicated by the concurrent effects that school contexts exert on principals" (p. 528). Several factors, including the strengths of the principal, the makeup of the school faculty, and the context facing the school, must be considered when attempting to identify effective leadership practices. In spite of the challenges of isolating which of the many emphases of principals best support improvements in teaching and learning, our analysis of the evidence base points to three factors that seem to be commonly referenced across the literature. The first factor is the role principals play in focusing the mission and goals of the organization. The second factor is how principals encourage an environment of collaboration and trust in the building. The third factor that has been consistently related to improvements in teaching and learning is the extent to which principals actively support instructional improvement.

Setting mission and goals. Many researchers see the key task of principal leadership to be setting the broad vision and mission of the organization and linking goals to that mission. Leithwood (1996), for example, argued that setting organizational direction was one of the core tasks of transformational leadership. Hallinger and Murphy (1987) contended that instructional leadership focused first on defining the school mission through a clear vision of what the school was trying to accomplish. Similarly, Hallinger et al. (1996) identified establishing a

clear school mission as a central activity of instructional leadership. Witziers et al. (2003) conducted a meta-analysis of seven leadership behaviors and found “defining and communicating mission” to have the largest effect size of all those they examined. Goldring and Pasternak (1994) studied principals’ activities and found that the principals’ roles in framing school goals, establishing a clear mission, and gaining staff consensus were strong predictors of school outcomes.

Encouraging trust and collaboration. Trust and collaboration point directly to the cultural heart of the school organization, and many studies identify principals as a central shaper of their schools’ culture. Bryk and Schneider (2002) used extensive survey data and case studies in Chicago to examine the connections between what they called “relational trust” and school outcomes, including student achievement. They defined relational trust as the social exchanges in schools defined by respect, personal regard, competence in core role responsibilities, and personal integrity. Through their analyses, they found that the growth of relational trust in schools “fuels the multiple strands of the school change process and thereby contributes to improved student learning” (p. 121). They identified trust levels between the school’s principal and teachers as a central indicator of trust. Heck, Larson, and Marcoulides (1990) examined principal supervision and support of teachers. They found that higher performing elementary and high school principals worked collaboratively with teachers to coordinate their schools’ instructional programs and solve instructional problems and supported staff development opportunities. In their met-analysis, Waters et al. (2003) identified the fostering of shared beliefs and a sense of community and cooperation to be one of the most significant leadership predictors of student learning outcomes.

Active support of instruction. A final set of research on effective principal leadership emphasizes the importance of both creating a learning ethos and providing more hands-on support for instruction. Leithwood, Jantzi, Silins, and Dart (1993) investigated how principals developed an instructional emphasis in schools. Relevant to this review, they found that principals who focused on developing an instructional vision, setting group goals, holding high expectations, and providing individual support for teachers positively influenced school culture and climate. In their review of the literature on leaderships effects on student achievement, Waters et al. (2003) found leaders’ knowledge of curriculum, instruction, and assessment to be a significant predictor of student performance. Supovitz and Poglinco (2001) examined the instructional leadership practices of urban school principals implementing a comprehensive school reform model. They found that instructional leaders organized their schools around an emphasis on instructional improvement supported by a distinct vision of instructional quality, cultivated a community of instructional practice in their schools by creating a safe and collaborative environment for teachers to engage in and deepen their work, and reorganized their own professional lives, time, and priorities to support instructional improvement.

Emerging Attention to Other Influential Actors in Schools

Concurrent with the recent research on principal leadership, an emerging trend in the study of leadership looks beyond the principal toward an array of other actors who either consistently, or situationally, take on a leadership role in schools. These perspectives come from conceptions of leadership that arise out of authority and influence. In this view, leadership is not exclusively positional but rather is rooted in the act of establishing influence over others. Schneier and Goktepe (1983) define such informal leadership as influence over other group members. Research from organizational sociology indicates that informal leaders have a strong influence on group processes, norms, and outcomes (Bass, 1990; Wheelan & Johnston, 1996). Pescosolido (2001) argues that informal leadership that develops within a group plays a key role in defining the group's sense of efficacy.

One of the foundational educational theorists on this topic, Peter Gronn (2000), argues for a reallocation of the tasks and activities that constitute the division of labor in schools toward a system of "joint performance." James Spillane and colleagues have written extensively about a distributed perspective on leadership. In their view, leadership arises not from formal title or responsibility but rather out of the interactions among individuals, tasks, and situations (Spillane, 2006; Spillane, Hallett, & Diamond, 2003; Spillane, Halverson, & Diamond, 2001). Wider conceptions of leadership have led to recent explorations of the role and influence of informal leaders and teacher leaders (Mangin & Stoelinga, 2008; York-Barr & Duke, 2004). Robinson (2008) contrasts views of distributed leadership that emphasize tasks versus influence and theorizes that emphasizing influence makes it harder to link distributed leadership to educational outcomes.

Several key factors are emerging within the literature on how teachers influence their peers in educational settings. These include a collaborative interaction of faculty around issues of teacher and learning and the development of instructional advice networks. These are reviewed briefly below.

Active interaction among faculty around teaching and learning. An emerging finding in the teacher leadership literature is that peers influence each other when they engage in collaborative discussions about their professional work. In their review of the literature on teacher leadership, York-Barr and Duke (2004) found that relationship building and collaboration were the two foremost themes that emerged when they synthesized the research on teacher leadership activity. LeBlanc and Shelton (1997) identified collaboration as the primary means by which teachers affected their peers. Wasley (1991) conducted a series of case studies of teacher leaders. She found that those with the most influence worked collegially with other teachers to examine instruction and its effects on student learning. The Bryk and Schneider (2002) work on relational trust that was discussed earlier also demonstrated the importance of teacher-teacher trust as a significant factor in improving school communities and student learning outcomes.

One key strategy by which teachers influence their peers has come to known as peer coaching (Joyce & Showers, 1995; Showers, 1984). Peer coaching is a strategy to increase the transfer of professional development by having teachers do sustained work on what they have learned in professional development (Showers & Joyce, 1996). Two key elements of peer coaching are to have teachers observe each other teaching and to examine student work in relation to assignments. The latter is a central part such educational movements as understanding by design, in which teachers backward map from desired results to evidence for results to learning experiences and instruction (Wiggins & McTighe, 2001).

Strong instructional advice networks. Another way that teachers influence their peers is via instructional advice networks. Researchers are beginning to unpack the ways in which teachers provide and seek assistance from each other through social networks and the influence of these instructional networks on school improvement efforts and outcomes (Frank, Zhao, & Borman, 2004; Supovitz, 2008). Based on theories of social capital, individual and collective benefits accrue through dense and interrelated networks among individuals (Coleman, 1997; Burt, 2000; Lin, 2001). Supovitz (2008) studied school reform networks and found that most of the instructional support was provided by teachers who did not hold formal leadership positions. Spillane (2005) illustrated how leadership practice in primary schools was structured differently depending on the content area. Weinbaum, Cole, Weiss, and Supovitz (2008) examined communication networks in high schools implementing external reforms. They found positive relationships between school communication patterns and attitudes and behaviors in support of the reforms, suggesting a relationship between communication and reform practice.

In sum, the literature on how peers influence each other in schools is in a more nascent stage than the more mature literature base around principal leadership. However, several important themes are emerging. Foremost is the ways in which teachers have collaborative opportunities to interact around issues of teaching and learning. Second are opportunities to observe each other's teaching and the resulting conversations. A third, and perhaps related, trait of instructional interaction among peers is both formal and informal instructional advice networks.

Conceptual Framework for This Study

Drawing on the different trends in the research on both principal leadership and how teachers influence their peers in schools, we constructed a conceptual framework that describes how these two latent factors influence instruction and student learning. Our conceptual framework is depicted in Figure 1.

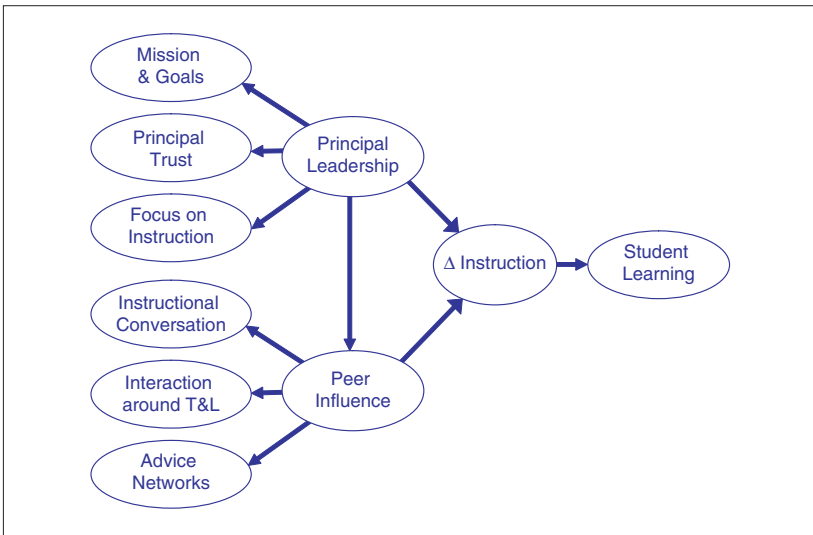


Figure 1. Study conceptual framework

Principal leadership is conceptualized as a construct made up of leaders' emphasis on mission and goals, emphasis on community and trust, and focus on instruction. We call our second construct "peer influence" to emphasize the act of teachers' influencing their colleagues rather than its leadership quality. In doing so we conceptualized peer influence as a latent factor composed of instructional conversations, interactions among faculty members around issues of teaching and learning, and instructional advice networks. These three overlap, but we viewed them as conceptually distinct. We conceived of instructional conversations as collegial discussions among peers about instructional issues. We viewed interactions among faculty members around issues of teaching and learning as particular acts such as conducting observations, providing feedback, and reviewing student work together. And we conceptualized advice networks as the specific seeking of instructional assistance from particular peers. We also hypothesized principal leadership to unidirectionally affect the extent to which teachers influenced their peers inside of schools, as represented by the arrow going from principal leadership to peer influence. Both principal leadership and peer influence are theorized to influence teachers' instructional practice, which is conceived to be directly related to student learning outcomes.

Research Method

Research Questions

Based on this theoretical model, we developed a set of five research questions, stated below:

1. Is principal leadership associated with teacher change in instruction?
2. Is principal leadership associated with teacher peer influence?
3. What is the relative magnitude of the association of principal leadership and peer influence with teacher change in instruction?
4. Is there a relationship between teacher change in instruction and increases in student learning in mathematics and/or ELA?
5. In light of findings from the above questions, what are the indirect relationships among principal leadership, peer influence, change in instruction, and student learning?

Sample

The data to address these research questions come from a mid-sized urban district in the southeastern United States. They were collected as part of an ongoing study of educational leadership and principal professional development discussed elsewhere in this journal edition. Cloverville (a pseudonym) has 52 schools, 30 elementary schools, 10 middle schools, 8 high schools, and 4 specialty schools. The district student population is approximately 66% Black and 27% White, with about 58% of the students on free or reduced-price lunch. This study utilized two data sources, teacher surveys and student achievement data.

The teacher surveys provided measures of both leadership practice and peer influence on teachers. An earlier study of the data from Cloverville had shown that there were broad differences between principal reports and teacher reports of principal leadership (Goldring, Huff, Pareja, & Spillane, 2008). Based on this finding, in combination with the lineage of the literature that indicated that principals tended to influence student performance indirectly through influence on teachers, we sought to understand principal leadership from the perspective of teachers. By doing so, we made the explicit decision to view principal leadership from how teachers perceived it to be enacted rather than from the perspective of what principals intended. Therefore, we focused on teacher perceptions of both principal leadership and peer influence. The teacher data came from a 2007 administration in which Cloverville teachers completed a thorough survey regarding their background, the school as a workplace, professional development, and school change, with an 81% response rate.

Student achievement data for the years 2006 and 2007 were collected and linked using a district-provided unique student identifier. These records were then linked to teachers using a teacher identifier for 2007. This study examines both mathematics and ELA student achievement in Grades 1 to 8. High school students were not included because testing did not allow us to measure changes in performance from 2006 to 2007. To ensure that the teacher link provided by the district was the subject teacher for both mathematics and ELA, only teachers and students in self-contained classrooms were retained for the final analysis. Of the 15,053 total number of Grades 2 through 8 students in 2007, 11,397 were used in the analysis. This represents a 24% reduction in the sample because of an inability to make either a student link or a teacher link or because the teacher was not in a self-contained classroom. The final sample included 38 elementary and middle schools and 721 teachers.

Measures

Dependent variables. Two years of student records in Grades 1 through 8 were obtained from district databases, including end-of-year standardized test scores and administrative data on each student's race, sex, limited English proficiency status, and free or reduced-price lunch participation. The 2005-2006 school year was regarded as the pretest year and the 2006-2007 school year as the posttest. Concurrent with this time period, the state was transitioning to an updated version of the state test to maintain alignment with recently updated state standards. This complicated our analyses in that the transition to the new test was phased in for some grades earlier than in others. Furthermore, the two versions of the test were not equated, resulting in very different scales for the two sets of scores. Of our student sample, 13% were given the old test in both years, 59% took the new test in both years, and 28% had one of each. To place the two assessments on the same scale, test scores were standardized (i.e., converted to z scores) by test version, subject, and grade across all students in the analyzed sample.

As a result of the within-grade and -subject standardization, the rescaled test scores reflect performance relative to the average student (for that grade and subject) in standard deviation units. To better model student learning during the 2006-2007 school year, we calculated a gain score for each student by subtracting spring 2006 scores from spring 2007 scores. We chose to use gain scores as opposed to a covariance approach given that research on Lord's paradox (see Holland & Rubin, 1983; Wainer, 1991) suggests that difference scores produce less biased results than covariance analysis when the dependent variable does not exhibit natural growth (which is the case with the z scores used in our analyses).¹

Independent variables. In May 2007, Cloverville teachers answered a school staff questionnaire regarding their background, the school as a workplace, professional development, and school change. The school staff questionnaire was administered in the school setting and had an 81% response rate for the 38 elementary and middle schools in the study. For this study, seven areas of school climate and teaching practice were measured: three relating to principal leadership, three to peer teacher influence, and one to change in instructional practice (see the conceptual framework represented in Figure 1).

Scale development was carried out using a combination of previous empirical work (Camburn, Rowan, & Taylor, 2003) as well as pertinent theory of each dimension of principal leadership and peer influence. In all, 29 indicator survey items were used and had 6% missing data, which were imputed using the Expectation Maximization (EM) algorithm prior to model estimation. Imputed values were then rounded to the nearest scale value.

The seven scales developed for this study are shown in Table 1. Three scales of teacher perceptions of principal leadership were derived from survey items: Mission and Goals, Principal Trust, and Focus on Instruction. These scales were highly reliable, with Cronbach alphas greater than .90. Three scales representing peer influence were also developed from the survey: Instructional Conversation, Interaction Around Teaching and Learning, and Instructional Advice Networks. These scales were slightly less reliable, with Cronbach alphas around .80.

The scale measuring instructional advice networks was different than the other scales, which were all developed from closed-ended Likert-type items. By contrast, the instructional advice network scale was derived from a social network question that asked teachers who they turned to for assistance in the appropriate subject area (ELA and mathematics). From these responses, two numbers were used to produce the Instructional Advice Network scale. The first was simply the out-degree, or the number of requests for collaboration and assistance that an individual makes of his or her peers, which we used to represent his or her instructional resources. The second was the number of peers an individual sought advice from outside of his or her grade level or content area, which we took to represent instructional resources beyond his or her immediate network.

The final scale was Teacher-Reported Change in Instruction. This scale was composed of teachers' responses to four items that asked them about the degree to which they had changed various aspects of their teaching. A full description of the individual items constituting each of these seven scales, along with their descriptive statistics, is presented in Appendix A.

Because the scales were not developed by exploratory methods alone, a confirmatory analysis was performed to validate their use. The 29 items were submitted to an oblique, multiple group, principal components cluster analysis (Anderberg, 1973; Harman, 1976) to confirm the composition of the theorized

Table 1. Scales Used in Study and Reliabilities

Scales of Principal Leadership

Mission and Goals (5 items, $\alpha = .90$)—Teacher perceptions of the extent to which their principal has an instructional mission and related goals

Principal Trust (5 items, $\alpha = .93$)—Teacher perceptions of a trusting relationship with their principal

Focus on Instruction (5 items, $\alpha = .91$)—Teacher perceptions of principal expertise and focus on instruction

Scales of Peer Influence

Instructional Conversation (4 items, $\alpha = .81$)—Teacher perceptions of conversations with peers around instructional issues

Interaction Around Teaching and Learning (4 items, $\alpha = .76$)—Teacher perceptions of conversations with peers around instructional issues

Instructional Advice Networks (2 items, $\alpha = .85$)—Social network items that assessed degree of instructional assistance (density) and extent to which teachers sought assistance outside of their grade or subject area (spread)

Scale of Change of Instruction

Teacher Change in Instruction (4 items, $\alpha = .94$)—Teacher self-reported change in instruction

dimensions (see Appendix A). Initial group membership was provided, and items were then permitted to migrate iteratively to dimensions that better explain item variance. No item migrated from its hypothesized dimension. Item membership in respective hypothesized groups was able to explain 73% of the total variance, as opposed to only 27% when each item was assigned to its best alternative dimension. All of the factors had a standardized Cronbach's alpha coefficient greater than or equal to .70, and all were deemed to be reliable for this sample in terms of overall internal consistency (Cronbach, 1951) A correlation matrix for the scales is shown in Appendix B.

Analytic Model

A multilevel structural model with latent variables was specified to investigate principal and peer influences on change in teacher instruction as it relates to student learning. All of the seven dimensions listed in Appendix A were specified by their member items in the measurement model. Our structural model consists of principal and peer influence as second-order factors that are predictive of change in teachers' instructional practice. A structural path was also included from principal leadership leading to peer influence to allow principals to have an indirect association with teacher instruction through the influence of the community of teachers.

A multilevel framework was used to allow for the clustering of students within a teacher's classroom. This was necessary to calculate an unbiased estimate and proper confidence interval for the association of change in teacher instruction with student learning. By specifying two levels, variation in student learning is partitioned between and within classrooms, such that student covariates are allowed to explain differences between student learning within a class and teacher instruction explains the differences between the class averages.

The factor loadings for all 29 observed indicators are given in Appendix C. Of the 29 factor indicators, 27 were assumed to be normally distributed, whereas the 2 social network variables were treated as count data by assigning a Poisson distribution. All disturbance terms among first-order factors as well as error terms among factor indicators were regarded as uncorrelated.

Each first-order factor was identified by its most reliable indicator; second-order factors were each standardized. The model was estimated using Mplus 5.1 (Muthén & Muthén, 2007). The estimation method employed was maximum likelihood with robust standard errors and, the EM optimization algorithm was used in conjunction with numerical integration to obtain sample statistics for model estimation. Convergence was met after 56 and 62 iterations for the ELA and mathematics models, respectively.

In addition to students and teachers, the clustering of teachers within a school should be modeled to improve the efficiency of estimates and to correct the confidence intervals. Because this third level is not available in the analytic software used, the model estimates may have standard errors that are too large. To conservatively account for the possible clustering effect, the intraclass correlation and average cluster size were used to adjust the standard errors by multiplying them by the square root of the design effect (Higgins & Green, 2006).

Results

The results demonstrate a positive association for both principal and peer influence with teachers' change in instructional practice in both ELA and mathematics. The structural path from principal leadership to peer influence was also shown to be significant in both subjects. Finally, the direct relationship between teachers' change in instructional practice and whole-class change in student learning was demonstrated for ELA but not mathematics. Table 2 presents the structural path coefficients estimated in the multilevel structural model.

These results allow us to directly address the first four of our research questions. Our first research question was whether principal leadership was associated with teacher change in instruction. We found that principal leadership was a positive and significant predictor of a teachers' change in instruction for both ELA and mathematics. This suggests that principals who focus on instruction, foster community and trust, and clearly communicate school mission and goals

Table 2. Standardized Direct Effects of Principal Leadership and Peer Influence on Teacher Instruction and Student Learning (with standard errors in parentheses)

Predictor	Outcome	English		Mathematics	
		Language Arts			
Teacher level					
Principal leadership	Change in instruction	.18	(.05)***	.14	(.04)***
Peer influence	Change in instruction	.21	(.05)***	.26	(.05)***
Principal leadership	Peer influence	.38	(.05)***	.30	(.05)***
Change in instruction	Student learning	.11	(.05)**	-.04	(.04)
Student level					
Male	Student learning	.02	(.01)	.02	(.01)**
Minority	Student learning	-.01	(.01)	.00	(.01)
Poverty	Student learning	.02	(.01)*	.01	(.01)
Limited English proficiency	Student learning	.02	(.01)**	.03	(.01)***
Elementary	Student learning	-.03	(.02)	.06	(.02)***

Note: Factor loadings for this model are provided in Appendix C.

* $p < .10$. ** $p < .05$. *** $p < .01$.

are associated with teachers who report making a greater degree of changes to their instructional practice.

Our second research question asked if principal leadership was associated with teacher peer influence. We found that the largest and most significant relationship in the structural model was the effect of principal leadership on peer influence. School leadership, characterized in this model by the development of mission and goals, an environment of collaboration and trust, and a focus on instructional improvement, appears to foster an environment where teachers work together and constructively engage with each other around issues of teaching and learning. Our model also shows that peer influence was a positive and significant predictor of teachers' change in instruction for both subjects. Higher levels of instructional conversation, interaction around teaching and learning, and advice networks among peer teachers were associated with increases in the amount of change in instruction that a teacher reports.

Our third research question asked about the relative magnitude of the association of principal leadership and peer influence with teacher change in instruction. In both ELA and mathematics, as can be seen by comparing the standardized coefficients in Table 2, peer influence had a higher direct association

with change in instruction than did principal leadership. In mathematics, the magnitude of the difference between the effects of peer influence relative to principal leadership on teachers' self-reported instructional practice was nearly twice as large.

The fourth of our research questions asked if there was a relationship between teacher change in instruction and increases in student learning in mathematics and/or ELA. Our findings showed that, after controlling for a variety of student background characteristics, there was a moderately sized and statistically significantly positive association between teachers' self-reported change in instruction and student performance in ELA. There was no significant association in mathematics.

Our final research question involved further examination of the indirect relationships among principal leadership, peer influence, and student learning. Educational leadership influences instructional practice, which changes student performance. The results of the effect of leadership on instruction are largely consistent in ELA and mathematics models, although change in instruction was not a significant predictor of student math learning. Tracing the relationship of student achievement back to principal leadership and peer influence allows quantification of the indirect and total effects and corresponding cluster-corrected standard errors, which are presented in Table 3 for ELA only.

The first four rows of statistics display the indirect effects of principal leadership and peer influence on change in ELA instruction and student learning. Principal leadership is significantly related to student learning through change in instruction. Also displayed are total effects, which are the sum of all associations between the predictor variable and outcome through direct and indirect paths. Although the total effect of teacher peer influence on ELA student learning is .02 ($SE = .009$), the total principal leadership association is .03 ($SE = .00$).

Discussion

This research provides both a confirmation of previous work as well as new contributions to the research on the chain of hypothesized relationships between leadership practice and student learning. First, consistent with the lineage of studies of principal leadership on student learning (Hallinger & Heck, 1998; Leithwood et al., 2004; Waters et al., 2003; Witziers et al., 2003), we found empirical evidence that principal leadership influences student learning indirectly through teachers' instructional practices.

A major contribution of this research is the strong and significant impacts of teacher peer influence on instructional practice. The second-order latent factor of peer influence had a statistically significant impact on teachers' instructional practice in both ELA and mathematics. This provides some of the first empirical evidence of the influence of teachers' leadership on the

Table 3. Standardized Indirect Effects of Principal Leadership and Peer Influence on English Language Arts Teacher Instruction and English Language Arts Student Learning

Indirect Effects				
Predictor	Outcome	Via	<i>b</i>	SE ^a
Principal	Instruction	Peer	.08	(.26)
Principal	Student	Instruction	.02	(.00)***
Principal	Student	Peer/instruct	.01	(.03)
Peer	Student	Instruction	.02	(.08)
Total Effects				
Predictor	Outcome			
Principal leadership	Student learning		.03	(.00)***
Peer influence	Student learning		.02	(.09)

a. Standard errors are adjusted for the clustering effect by multiplying by the square root of the design effect for the outcome variable (Higgins & Green, 2006).

*** $p < .001$.

classroom practices of teachers that produce student learning outcomes. This supports some of the key contentions in the emerging teacher leadership literature (Mangin & Stoelinga, 2008; Spillane, 2006).

There was also an important difference between content areas in our findings. In ELA, the impact was on par with the impact of principal leadership on instructional practice. In mathematics, the impact of peer influence on teaching practice was almost twice the magnitude of that of principal leadership. This suggests that in mathematics, with which principals might tend to be less comfortable, teacher leaders fill the breach by providing important support and assistance.

Principals have an indirect association with a teacher's change in instruction that is mediated by teacher peer influence. For both ELA and mathematics, the total effect that principals have on change in instruction, which includes both the direct and the indirect effects, increases dramatically by a standardized effect of .08 when including their indirect effect through peer teacher networks.

The indirect effects of principals and peer teachers were also significantly associated with ELA student learning. Although peer influence has a greater *direct* effect on teacher instruction, principal leadership has a greater *total* effect on ELA student learning because of the *indirect* effect through teacher peer influence. This implies that principals are the most important actor in student learning in ELA, in part because of their indirect influence on teacher instruction through collaboration and communication around instruction between peer teachers. Through fostering a climate of instructional collaboration, principals have the greatest impact on learning.

The use of multilevel SEM provided several advantages in this investigation. First, latent variables could be estimated in the same model in which they were used as independent and dependent variables. Second, this framework afforded us the ability to specify complex relationships among the variables of interest, wherein locally dependent variables in parts of the model were used as predictors of other variables. Teacher instruction and student learning were specified as the proximal and distal outcomes, respectively, of principle and peer teacher influences.

Several weaknesses of our study cause us to be conservative and temper our findings. First, we used teacher self-report data for our key measures. Although these are relatively easy to collect, they may misrepresent key constructs in our data. In particular, having teachers self-report on changes in their instructional practice is less than ideal. In addition, our findings may have differed if we had used principal reports of their leadership practice rather than teacher reports of principal leadership practice. One reason for this is that our measures of leadership practice are likely to be influenced not only by what principals do but also by teachers' individual opinions of their principal. On the other hand, it is possible that the teacher-report measures used here provide a more accurate picture of principal leadership than principals' own reports. Furthermore, we would argue that teachers are affected by principals' practices in different ways and to varying degrees. As such, our measures of leadership practice may do a better job of capturing the variation with which principals influence teachers.

These analyses also point to a series of future analyses that would extend this work. First, should these analyses be replicated with data from high schools, we believe the results would look very different. Second, we would like to see a better measure of instructional practice used. Teacher self-report is potentially misleading (Cohen, 1990), and more objective measures may produce different results. Finally, we would also be curious to replicate these results using principal perceptions of their leadership as opposed to teacher perceptions of principal leadership and also to explore the factors that explain variation in teachers' perceptions of their principal's practice.

The consuming obsession with accountability in the first decade of the 21st century has led educators to seek connections between virtually any educational endeavor and student learning outcomes, regardless of the length of the logic chain between the two. In this context, school leadership has been scrutinized for its detectable contributions to student learning. The findings of this study support many others in the commonsense notion that the main impact of principals is not directly on students but on teachers who interact with students directly on a daily basis. Our findings suggest that principal influence is even broader and that principals work through other leaders in schools to influence what goes on inside of classrooms. This indirect pathway points to ways that principals' attention to

Appendix A

Descriptive Statistics and Confirmatory Analysis of Scale Dimensions

	Descriptive Statistics				Confirmatory Analysis ^a				
	M	SD	Min	Max	R ² With Own	R ² Next Closest	R ² Next Closest	Loading	Loading
Mission and Goals ($\alpha = .90$)									
Communicates expected standards ^b	3.16	0.85	1	4	.69	.49	.49	.83	.83
Encourages raising test scores	3.19	0.82	1	4	.62	.29	.29	.79	.79
Expects me to meet instructional goals	2.99	0.92	1	4	.79	.50	.50	.89	.89
Communicates standards for learning	2.97	0.95	1	4	.82	.52	.52	.91	.91
Expects teachers to continually grow	3.13	0.82	1	4	.70	.48	.48	.84	.84
Community and Trust ($\alpha = .93$)									
I feel respected by the principal	3.22	0.72	1	4	.84	.39	.39	.92	.92
Makes me feel comfortable	3.49	0.59	1	4	.78	.37	.37	.88	.88
I trust principal at his or her word	3.24	0.75	1	4	.83	.46	.46	.91	.91
Okay to discuss feelings/frustrations	3.24	0.75	1	4	.81	.36	.36	.90	.90
Takes a personal interest in teachers	3.38	0.63	1	4	.68	.49	.49	.83	.83
Focus on Instruction ($\alpha = .91$)									
Knows what is going on in classrooms	2.80	0.87	1	4	.76	.45	.45	.87	.87
Monitors quality of instruction ^b	2.93	0.80	1	4	.76	.54	.54	.87	.87
Made me aware of resources ^b	2.88	0.81	1	4	.74	.48	.48	.86	.86
Encourages sharing of ideas	3.17	0.75	1	4	.68	.50	.50	.83	.83
Helps struggling teachers	2.58	0.94	1	4	.71	.45	.45	.84	.84
Instructional Conversation ($\alpha = .81$)									
Peer conversations about student learning	3.43	1.10	1	5	.56	.09	.09	.75	.75

(continued)

Appendix A (continued)

	Descriptive Statistics					Confirmatory Analysis ^a			
	M	SD	Min	Max		R ² With Own	R ² Next Closest	Loading	
Peer conversations about new curriculum	2.62	1.16	1	5		.45	.06	.67	
Peer conversations about instruction ^b	2.95	1.35	1	5		.77	.12	.88	
Peer conversations about content standards ^b	2.87	1.31	1	5		.79	.10	.89	
Interaction Around Teaching and Learning ($\alpha = .76$)									
Observed other teachers teach	1.85	0.94	1	5		.52	.03	.72	
Other teachers observed you	1.89	0.87	1	5		.74	.02	.86	
Give teacher feedback	1.65	0.75	1	5		.65	.05	.81	
Others reviewed your students' work	2.25	0.99	1	5		.43	.09	.65	
Advice Networks ($\alpha = .85$)									
# teachers to whom to turn for advice ^{b,c}	1.08	1.37	0	7		.87	.08	.93	
# teachers out of grade who advise ^{b,c}	0.51	0.89	0	7		.87	.06	.93	
Change in Instruction ($\alpha = .94$)									
Change teaching methods ^b	3.92	1.45	1	7		.87	.07	.93	
Change assigned student work ^b	4.04	1.43	1	7		.88	.05	.94	
Change kinds of questions asked ^b	4.00	1.47	1	7		.87	.06	.93	
Change understanding of student needs ^b	4.18	1.49	1	7		.76	.05	.87	

Note: N = 1,442.

a. Confirmatory analysis performed by variable cluster analysis.

b. Subject-specific question for English language arts or mathematics with otherwise identical wording.

c. Social network variables treated as continuous, although structural equation modeling treats as count data.

Appendix B

Factor Correlations

	1	2	3	4	5	6	7
1. Mission and Goals	1.00	.64	.79	.29	.08	.13	.18
2. Community and Trust		1.00	.72	.23	.08	.13	.15
3. Focus on Instruction			1.00	.34	.19	.12	.23
4. Instructional Conversation				1.00	.27	.29	.26
5. Interaction Around Teaching and Learning					1.00	.94	.19
6. Advice Networks						1.00	.10
7. Change in Instructional Practice							1.00

Notes: Correlation matrix produced using variable cluster analysis procedure.

All correlations are significant at the $p < .005$ level.

Appendix C

First- and Second-Order Factor Loadings for Principal Leadership, Peer Influence, and Change in Instructional Practice (with standard errors in parentheses)

Factor	Indicator	English Language Arts	Mathematics
First-Order Factor Loadings Mission and Goals	Communicates expected standards	.81 (.02)	.79 (.02)
	Encourages raising test scores	.69 (.03)	.70 (.03)
	Expects me to meet instructional goals	.87 (.01)	.86 (.01)
	Communicates standards for learning	.90 (.01)	.90 (.01)
Community and Trust	Expects teachers to continually grow	.79 (.02)	.78 (.02)
	I feel respected by the principal	.90 (.01)	.90 (.01)
	Makes me feel comfortable	.85 (.02)	.85 (.02)
	I trust principal at his or her word	.90 (.01)	.90 (.01)
Focus on Instruction	Okay to discuss feelings/frustrations	.87 (.02)	.87 (.02)
	Takes a personal interest in teachers	.78 (.02)	.78 (.02)
	Knows what is going on in classrooms	.84 (.02)	.84 (.01)
	Monitors quality of instruction	.83 (.02)	.85 (.01)
	Made me aware of resources	.81 (.02)	.82 (.02)
	Encourages sharing of ideas	.79 (.02)	.79 (.02)
Instructional Conversation	Helps struggling teachers	.80 (.02)	.80 (.02)
	Peer conversation about student learning	.54 (.03)	.47 (.03)
	Peer conversation about new curriculum	.42 (.02)	.40 (.04)
	Peer conversation about instruction	.93 (.02)	.95 (.01)
	Peer conversation about content standards	.94 (.01)	.95 (.01)

(continued)

Appendix C (continued)

Factor	Indicator	English Language Arts	Mathematics
Interaction around Teaching and Learning	Observed other teachers teach	.63 (.05)	.63 (.05)
	Other teachers observed you	.86 (.03)	.86 (.03)
	Give teacher feedback	.70 (.05)	.70 (.05)
Advice Networks	Others reviewed your students' work	.49 (.04)	.49 (.04)
	# teachers turned to for advice	.100 (.00)	.100 (.00)
	# teachers out of grade turned to for advice	.100 (.00)	.100 (.00)
Change in Instruction	Change teaching methods	.91 (.01)	.92 (.01)
	Change assigned student work	.93 (.01)	.94 (.01)
	Change kinds of questions asked	.89 (.02)	.92 (.01)
	Change understanding of student needs	.78 (.03)	.83 (.03)
Second-Order Factor Loadings Principal Leadership	Mission and Goals	.88 (.02)	.87 (.02)
	Community and Trust	.77 (.02)	.77 (.02)
	Focus on Instruction	.99 (.01)	.99 (.02)
Peer Influence	Instructional Conversation	.91 (.08)	.92 (.07)
	Interaction Around Teaching and Learning	.19 (.06)	.27 (.05)
	Advice Networks	.53 (.06)	.61 (.05)

All correlations are significant at the $p < .001$ level.

such central school improvement concepts as mission and goals, community and trust, and instructional focus have subtle yet real organizational influence. Principals, working with and through the range of other school actors who exert influence on teachers, do affect the instructional practice of teachers that produces improvements in student learning.

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Note

1. Although there was a clear statistical argument for using difference score analysis instead of covariance analysis, we also ran the model using a covariance approach and found similar results, indicating that the transformation of scores did not influence the findings.

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