A Longitudinal Study of Principals' Activities and Student Performance

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Abstract

With the movement toward increased accountability for student performance at the school level, there has been a simultaneous movement toward increased emphasis on the responsibility of school principals to improving teaching and learning (Leithwood & Riehl, 2003; Murphy, 2002; Stein & Spillane, 2003). Although a substantial amount of research on school leadership has focused on what principals' do, little of this research has explored how principals' activities may relate to and possibly affect student performance. This paper presents results from a three-year longitudinal study of principal activities and student performance. A three level HLM growth model (test scores nested within students, and students nested within schools) was employed to determine the degree to which principals' activities were associated with student performance at baseline, and changes in student performance over time. This approach allows us to see how (1) specific principal activities are more or less prevalent in high or low-performing schools, and (2) whether changes in the amount of time a principal spends on each activity is associated with changes in student performance.

Introduction

With the movement toward increased accountability for student performance at the school level, there has been a simultaneous call for principals to take more responsibility for improving teaching and learning in their schools (Leithwood & Riehl, 2003; Murphy, 2002; Stein & Spillane, 2003; Hallinger, 2005). This push has come in part from widespread agreements between researchers and policymakers alike that principals' instructional leadership is key to increased student achievement; both groups believe that these leaders are central to focusing their schools on improved teaching and learning. And yet existing research reveals a complex relationship between principals and student achievement. Leaders' impacts on student learning are often indirect, mediated through connections such as teacher pedagogy and other school conditions (Hallinger & Heck, 1996) and these relationships make it difficult to model the influence of leadership on achievement. Although a substantial amount of research on school leadership has captured what principals do, little of it has explored how principals' activities relate to and possibly affect student performance.

The purpose of this paper is to examine leadership practice closely to address the question, what are the relationships between principals' activities and student achievement? The paper presents findings from a three year, longitudinal study of all school principals in one school district in the southeastern United States. During this time principals were asked to complete a series of daily logs regarding their activities, and we also obtained student achievement data for these three years. Our analyses of the logs and the student achievement data allowed us to examine whether (1) specific principal activities are more or less prevalent in high or low-performing schools, and (2) whether changes in the amount of time a principal spends on each activity are associated with changes in student performance.

We first discuss more recent efforts to examine the relationship between leadership and student achievement, and we review different questions that remain for the field to address in this area. We then present our analyses and findings before discussing how they help to address these outstanding issues.

Literature Review

While researchers often agree that strong leadership is important for successful schools, establishing and demonstrating the links between leadership and student achievement have proven to be challenging tasks. For example, much of the earlier effective schools research in the 1970's and 1980's reported that effective schools often contained strong leaders who were integral to their successful organization and focused on rigorous teaching and learning, yet multiple studies during this time failed to show significant relationships between leadership and achievement (see for example Glasman, 1983; O'Day, 1983; and van de Grift, 1990). Furthermore, while various studies supported the general notion that school leaders are integral to improving schools, this literature often ignored the more complex contexts of schools and how leaders addressed these conditions (Hallinger & Murphy, 1986; Hallinger, Leithwood, & Murphy, 1993). Critiques that pointed out these limitations along with papers that questioned the empirical validity of connections between principals and student achievement (Miskel, 1982; Rowan, Dwyer, & Bossert, 1982) challenged researchers to look more closely at these relationships. The ensuing work has revealed a complex relationship between school leadership and their students' achievement, and multiple questions remain. Even after several decades of school renewal efforts and research, key questions that remain are just *how* leadership matters, which leadership actions help to improve teaching and learning, and what are the essential ingredients of successful leadership (Leithwood, Louis, Anderson, and Wahlstrom, 2004). In

this literature review we focus primarily on studies conducted in the 1990's and 2000's to connect this research to more recent findings.

Hallinger and Heck's (1996a, 199b, and 1998) reviews have been widely cited in this discussion, and they provide a helpful guide to much of the initial 1990's research. Two primary groupings they use to summarize the material include studies that examined direct connections between leadership and student achievement and studies that traced indirect connections between school leaders and student achievement. Those earlier "direct-effects models" that used primarily bivariate analyses such as correlations, t tests, or chi-square were unable to produce consistent evidence of leadership effects on student outcomes. These direct models both lacked conclusive results and suffered from conceptual limitations: without mediating variables they limited our understanding of how principals may influence both the school organization in general and student achievement more specifically (Hallinger & Heck, 1998, p. 166).

Recent, more complex models that include mediating variables have shown greater promise to trace leaders' impacts on students through indirect paths. Such studies have shown either mixed or consistent evidence of positive effects of leadership on student outcomes, and they also offer more robust conceptual models to capture the influence of leaders' actions on people and conditions directly connected to students (Hallinger & Heck, 1998, p. 167). Analytical methods such as structural equation modeling and hierarchical linear modeling have advanced to enable researchers to control for different factors that affect student achievement and account for the multilevel structure of schools, and these analyses have been much more successful in identifying the influences that leaders can have on student achievement (Heck, Larson, & Marcoulides, 1990; Leithwood, 1994; Hallinger, Bickman, & Davis, 1996). In addition, more recent meta-analyses of different studies have shown leadership effects ranging

from negligible (Witziers, Bosker, & Kruger, 2003) to moderate or strong (Marzano, Waters, & McNulty, 2005; Robinson, Lloyd, & Rowe, 2008). These moderate results mark some of the stronger connections to date that researchers have shown between leadership and achievement.

As these models and analyses have evolved, findings have shown that principals' engagement in a number of key activities help to explain many of their indirect effects on students. These activities fall into four main categories. They include a) principals' involvement in framing and sustaining their schools' vision or mission, b) their work to enhance the organizational and social structures in their schools (e.g. empowering teachers through roles in leadership, and collaboration in decision-making), c) their investment in their teachers through professional development and recognition of accomplishments, and d) their efforts to improve the culture or climate in their schools (in areas such as student and teacher expectations, and communication between school members) (Hallinger & Heck, 1998; Leithwood, et al., 2004). These results point to the importance of leaders' actions to shape different conditions in their schools that help to improve student learning, and they emphasize the need to examine these relationships between practice and achievement more closely.

Finally, research in this area has begun to use two additional strategies. First, Hallinger & Heck (1998) cited the growing call for using "reciprocal models" to account for the fact that "relationships between the administrator and features of the school and its environment are interactive" (p. 168). With the greater availability of methodological means such as structural equation modeling researchers have been better able to examine these interactions (Heck & Hallinger, 2008) to understand how much leaders influence their environments, and vice versa. Second, analyses of leadership effects have primarily used cross-sectional data, and researchers have only recently begun to use longitudinal data to examine leadership effects over time

(Hallinger & Heck, 1998; Robinson, et al., 2008). This strategy helps to better capture the dynamic nature of leadership and to examine whether or not changes in leadership have an impact on student outcomes. As scholars work to understand the connections between leaders and student achievement, these approaches can help to explain these complex relationships.

Research Questions

In this study we sought to answer two research questions that focus on the relationship between principals' leadership activities and student achievement. Our two primary research questions are:

1. Is the amount of time a principal spends on specific leadership activities related to the achievement of students in his or her school?
2. Are increases or decreases in the amount of time a principal spends on specific leadership activities related to the schools' value-added to student performance?

Because this study is observational, relationships observed do not allow us to draw strong conclusions about the causal relationships between principals' activities and student performance. For example, a positive relationship between a specific activity and student achievement might be interpreted with opposite causal direction—the principal's activity might lead to higher student performance, or higher performance might allow the principal to devote more time to the activity.

To begin to deal with this issue of causality, our second question focuses on simultaneous changes in the principal's activities and changes in value-added to student achievement. More specifically, we wish to evaluate whether shifts in a principal's activities from one year to the next are associated with increases or decreases in the schools' value-added to student performance for that school year. In essence, we seek to make two distinct comparisons in our

analyses. The first is a comparison of principals' activities across low and high performing schools. The second is a comparison of each principals' activities during the years in which their school produced lesser or greater value added to student achievement.

Methods

During a period spanning three school years from the spring of 2005 to the spring of 2007, principals from 39 elementary and middle schools in a southeastern urban school district participated in this study. Each principal was asked to participate in up to seven week-long data collection periods during which they completed daily logs documenting their activities. The activity logs required that principals document their activities in 15-minute intervals by classifying their primary activity at each point in time into one of nine categories as follows.

1. **Building operations:** schedules, space operations, building maintenance
2. **Finances and financial support for the school:** budgets, budget reports, seeking grants
3. **Community or parent relations:** formal meetings and information interactions
4. **School district functions**
5. **Student affairs:** attendance, discipline, counseling, hall/cafeteria monitoring
6. **Personnel issues:** recruiting, hiring, supervising, evaluating, problem solving
7. **Planning/setting goals:** school improvement planning, developing goals
8. **Instructional leadership:** monitoring/observing instruction, supporting teachers' professional development, analyzing student data or work, modeling instructional practices
9. **Principal professional growth:** formal professional development, attending classes at a college/university, reading books or articles

Principals' response data from the principal activity logs were aggregated to produce an activity profile for each principal, with the time spent on each type of the nine realms of responsibility coded as a proportion of the total time documented by the principal. This was done separately for each year, and the activity data was then linked to achievement data from individual students.

Achievement scores from the state assessment in English Language Arts (ELA) and Mathematics were obtained for 38,510 students enrolled grades 1 through 8 during the three-year period including the 2004-05, 2005-06, and 2006-07 school years. Given the natural matriculation of students into first grade and out of eighth grade, along with relatively high rates of mobility, only 16% of students in the sample had scores for all three years, 28% had scores for two years, and 56% had scores for only one year. The state assessment was not vertically scaled across grades, and changes in the test ruled out direct comparison of test scores from one year to the next. Therefore, test scores were standardized within each year and grade to reflect relative student performance. In other words, although the scores cannot be analyzed to determine absolute levels of student learning, they can be used to gauge shifts in the relative performance of students and groups of students (e.g., schools), relative to the larger population, from one year to the next.

A three level value-added HLM model (with test scores nested within students, and students nested within schools) was employed to determine the degree to which principals' activities were associated with student performance averaged across the three year period, and also changes in student performance over time. Each activity variable, denoting average hours per week spent on a specific realm of responsibility, was included in the model as both an overall school average for the three-year period, and as a time-varying covariate representing relative

emphasis in each year. For example, a principal might have spent an average of 30% of her time on instructional leadership during the three-year period (indicated by a value of .30 for the school average activity variable), but she might have spent the most time on instructional leadership, say 45% of her time, during the 2006-07 school year (indicated by a value of +.15 for the time-varying activity variable during Year 3). This approach allows us to see how (1) specific principal activities are more or less prevalent in high or low-performing schools, and (2) whether changes in the amount of time a principal spends on each activity are associated with changes in student performance.

The specification of the value-added statistical model is somewhat complex. The model is similar to the Tennessee Value-Added Assessment model described by Sanders, Sexton, and Horn (1997), except that our model focuses on estimating school-level value-added estimates (as opposed to teacher-level estimates), our model includes student and school characteristics as explicitly controlled covariates, and our model uses a simpler autoregressive structure for the repeated measures for one subject at a time. Because the variables representing time spent on the nine leadership activities are collinear (i.e., spending more time on one activity results in less time on others), a separate model is estimated for each activity. The general mathematical form of the model is:

$$Y_{tij} = \beta_o + \beta_1\left(MeanActivity_j\right) + \beta_1\left(Activity_{tj} - MeanActivity_j\right) + \sum \beta_k X_{k(i,j)} + \gamma_{tj}\left(Year_t * School_j\right) + \varepsilon_{tij}$$

where,

Y_{tij} = the test score of student *i* from school *j* during year *t*
β_0 = the model intercept
β_1 = the regression coefficient for the average time spent on a leadership activity
β_2 = the regression coefficient for time-varying variable for time spent on a leadership activity
β_k = is a set of regression coefficients for student and school-level control variables
γ_{tj} = is the value-added random effect for school *j* during year *t*

ε_{tij} = is the error term for the test score of student *i* from school *j* during year *t*, which is assumed to have an autoregressive structure Σ, where

$$\Sigma = \begin{bmatrix} \sigma_1^2 & & \\ \rho & \sigma_2^2 & \\ \rho^2 & \rho & \sigma_3^2 \end{bmatrix},$$

with σ_t^2 representing the residual variance of test scores in year *t*

The key benefit of this modeling strategy over traditional repeated measures analyses is that every student in the sample having at least one test score can be included in the analysis. The implication is that for students who have fewer than three test scores, it is assumed that their unobserved scores can be accurately predicted using the test scores that were actually observed along with student and school demographics.[1] This modeling approach also has an advantage of HLM growth curve models in that there is no functional form imposed on students' growth trajectories (e.g., linear, quadratic, etc.). Instead, year is treated as a discrete variable and is allowed to vary randomly for each school. This allows the model to handle the lack of vertical scaling in the test scores, given that each student's relative performance, along with school value-added, may go either up or down in any given year.

Results

Table 1 presents descriptive statistics for our measures of principals' activities. The most prevalent activity across the sample of principals was Student Affairs, which accounted for 23.3 percent of principals' time on average. A close second was Instructional Leadership, which accounted for 19.3 percent of principals' time on average. Four other activities (Building Operations, Parent Relations, Personnel Issues, and Planning & Setting Goals) each accounted for approximately 10 percent of principals' time on average. The remaining three activities (Finance, District Functions, and the Principal's Professional Growth) each accounted for

approximately 5 to 7 percent of principals' time on average. The standard deviation of each activity was substantial, ranging from 5 percentage points to almost 15 percentage points. This suggests a large amount of variation, either across schools or across years, in how principals allocate their time. The final two columns in Table 1 show how that variation is attributable to differences between schools, or differences across years within schools. The ratios of between and within school variation for each activity are not at all extreme. Building Operations has the least extreme variance partition, with a nearly even 1 to 1 split for between and within school variance. Even the most extreme split in the variance partition is surprisingly even—Instructional Leadership shows only a 3 to 1 ratio of variance between schools (76.3%) to variance within schools (23.7%). The distributions of time and variability in time allocations across the set of nine activities suggest that each activity demands a significant amount of a principal's time, that principals from different schools spend different amounts of time on different activities, and that a principal from a single school is likely to change substantially his or her allocations of time across leadership activities from one year to the next.

In our next stage of analyses, we estimated multilevel models connecting time spent on leadership activities to schools value-added to student achievement. Estimates of both fixed and random effects from the value-added models are presented in Tables 2 and 3 for ELA and Math, respectively. Results across the two subjects are very consistent. First, there are no significant differences in average performance across years (as indicated by non-significant fixed effects for Year2 and Year3), but there is consistently significant variance in school effects in each of the three years (as indicated by the highly significant random effects for Years 1, 2, and 3). This is not at all surprising, given that the test scores were standardized by year and grade to reflect relative performance over time, which has the effect of removing district-wide annual

differences, leaving only school-to-school differences in relative performance. The random effect estimates reveal that unmeasured school-level factors account for 3% to 6% of the variability in student performance. When compared to the random effect estimates from an unconditional model without any control variables (i.e., 8% to 10%), we see that approximately half of the school-level variability in student performance is explained by the student and school-level variables included in the models.

Across the models for ELA scores, four of the nine leadership activities are related to student performance; however, annual changes in principals' activities are not related to annual changes in school-level value added for any of the nine activities. This suggests that while some leadership activities may be more heavily emphasized by principals in lower or higher performing schools, changes in principals' leadership activities across the three year period are not related to changes in their schools' value-added to student achievement. Of the four activities that are related to overall student achievement, two activities are positively related and two activities are negatively related to student performance. A 10 percentage-point increase in the percent of time devoted to Finance issues is associated with a .18 standard deviation increase in student achievement. A 10 percentage-point increase in the percent of time devoted to Personnel issues is associated with a .08 standard deviation increase in student achievement. A 10 percentage-point increase in the percent of time devoted to Planning and Setting Goals is associated with a .14 standard deviation decrease in student achievement. Lastly, a 10 percentage-point increase in the percent of time devoted to Instructional Leadership is associated with a .06 standard deviation decrease in student achievement. It is important to note that the causal direction of these relationships cannot be established. It is possible that the activities lead to differences in performance, but it is perhaps more likely that differences in performance lead

to differences in leadership activities. For example, a decrease in student achievement in a school may cause a principal to focus more time on instructional leadership activities to help teachers address their students' learning needs.

Across the models for Math scores, three of the nine leadership activities are related to student performance, and one time-varying indicator of changes in principals' activities is related to annual changes in school-level value added. The three activities that are related to overall student achievement are a subset of the same variables found significant in the ELA models (i.e., Personnel Issues, Planning & Setting Goals, and Instructional Leadership), and the coefficients for these three variables are remarkably similar to those from the ELA models. The one time-varying covariate that is related to changes in school value-added is the proportion of time spent on building operations—a 10 percentage point increase in the percent of time a principal spent on building operations is associated with a .03 standard deviation increase in student performance. Upon visual inspection of the data for building operations, it was apparent that this relationship was likely driven by one school in which the principal spent an unusually large amount of time on building operations (i.e., over 20%) in one particular year.

Highly significant coefficients are observed for all four student-level covariates and one school-level covariate. All four student-level variables (male, minority, free lunch, and LEP) are associated with lower test scores. At the school-level, a higher proportion of minority students is associated with lower test scores. In ELA, we also see a weak negative relationship between achievement and the proportion of boys at a school. These effects are consistent with the literature on achievement gaps by gender, race, poverty, and English proficiency.

Perhaps the most important result from this analysis is reflected in the very high correlations between school value-added estimates over time. These correlations for adjacent

years are near or above .90, suggesting that school effectiveness is very consistent from one year to the next. Correlations in the low to mid-eighties between Year1 and Year3 school effects suggest that changes in school effectiveness happen very slowly.

The final unsurprising result from these analyses reveals a relatively high correlation between individual student test scores from one year to the next. The adjacent year correlation is estimated as .75 for ELA and .77 for math, suggesting that a student's test scores from one year are highly predictive of his or her test scores for the next year.

Discussion

We set out in this study to examine the relationships between principals' leadership activities and the performance of students in their schools. Our results indicated that while principals who spent relatively more time on finance and personnel issues tended to work in schools with higher test scores, and principals who spent relatively more time on planning and setting goals and instructional leadership tended to work in schools with lower test scores, we failed to establish evidence that changes in a principal's activities are associated with changes in a schools' value-added to student achievement.

One might be inclined to conclude from these results that principals' activities have little impact on student performance over a three-year period; however, one must recognize that our statistical models detect only systemic relationships that appear consistently across the full sample of students and schools. For example, our models are designed to detect whether a greater emphasis on instructional leadership is consistently associated with greater value-added to student achievement across the entire sample of schools. If the mechanisms by which principals influence student achievement are idiosyncratic and specific to each school, then our

models will fail to find relationships. In other words, if the success of a principal requires a different approach to leadership in any one school, then simple comparisons of time spent on activities will not reveal leadership effects on student performance. To capture those effects, we would need to establish not just what the principal was doing, but whether the principal's activities were focused on the most important things for improving his/her school.

Of those leadership activities that we found to be significantly related to student performance, we believe that the more plausible causal relationship is that school context drives principals' activities. This would match our previous findings regarding the importance of context to explain principal practice (Goldring, Huff, May, & Camburn, 2008), and it supports Hallinger & Heck's (1998) discussion of examining the reciprocal effects between leaders and school context. Principals in higher performing schools may simply have more time and capacity to focus on finance and personnel issues because they do not feel the same level of urgency and pressure to set goals or drive instructional reform as principals in the lowest performing schools. As the field continues to examine leaders' effects on student achievement, reciprocal models may help to capture more closely these relationships.

Undeniably, the results suggesting that school effects are highly consistent from year to year are sobering, perhaps disappointing, but not surprising. Schools are complex organizations, which typically serve hundreds of students, and often face substantial cultural and economic difficulties. To expect that large numbers of schools can dramatically change their outcomes in a short period of time is probably unrealistic. In addition, it is probably unrealistic to expect that an emphasis on one type of leadership activity would have a positive impact on student achievement in every school. It is probably more realistic to expect that each school has different characteristics and capacities, and that the most effective principals are able to evaluate these

factors and leverage the ones that are most likely to impact instruction and learning in their schools. Leithwood, et al. (2004) and others have stressed the contingent nature of leadership:

> There is a rich body of evidence about the relevance to leaders of such features of the organizational context as geographic location (urban, suburban, rural), level of schooling (elementary, secondary) and both school and district size. Each of these features has important implications for what it means to offer successful leadership.

These results also suggest that contextual factors not only have strong influences on student achievement but also exert strong influences on what actions principals need to take to successfully improve teaching and learning in their schools.

Finally, as researchers increasingly use longitudinal data to examine the effects of leaders in their schools, our results illustrate the importance of looking more closely at how individuals' practices vary across schools. As discussed above, this study has provided a more systematic examination of principal practices across schools, and these findings demonstrate the need to capture more closely individual principals' actions as they relate to their unique school conditions.

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Footnotes

[1] This is the Missing at Random (MAR) assumption as defined by Rubin (1987).

Table 1. Descriptive Statistics for Nine Principal Leadership Activities

	Percentage of Time Spent on Leadership Activity			
	Mean	Standard Deviation	Percent Variance Between Schools	Percent Variance Within Schools, Over Time
Building Operations	9.1	8.0	51.1	48.9
Finance	4.8	5.0	43.1	56.9
Parent Relations	10.1	6.5	61.3	38.7
District Functions	6.6	8.3	27.2	72.8
Student Affairs	23.3	13.7	68.3	31.7
Personnel Issues	10.6	9.2	36.5	63.5
Planning & Setting Goals	9.2	6.8	36.0	64.0
Instructional Leadership	19.3	14.7	76.3	23.7
Principal's Professional Growth	6.9	9.3	37.3	62.7

Table 2. Parameter Estimates from Multilevel Models of Student Achievement in ELA by Nine Principal Leadership Activities

	Principal Leadership Activity								
Model Parameters	Building Operations	Finance	Parent Relations	District Functions	Student Affairs	Personnel Issues	Planning & Setting Goals	Instructional Leadership	Principal's Professional Growth
Fixed Effects									
Intercept	1.02***	0.99***	1.05***	0.97***	1.11***	1.00***	1.20***	1.17***	1.15***
Year 2	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Year 3	-0.01	0.00	0.00	0.00	-0.01	-0.01	0.01	-0.01	-0.01
Average Proportion of Time on the Leadership Activity	0.04	0.18~	0.05	0.09	0.01	0.08~	-0.14*	-0.06*	-0.08
Changes in Proportion of Time on the Leadership Activity	0.02	0.00	0.00	0.00	-0.01	0.01	-0.01	0.00	0.00
Student-Level Controls									
Male	-0.29***	-0.29***	-0.29***	-0.29***	-0.29***	-0.29***	-0.29***	-0.29***	-0.29***
Minority	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***	-0.33***
Free/Reduced Lunch Eligibility	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***	-0.15***
Limited English Proficiency	-0.54***	-0.54***	-0.54***	-0.54***	-0.54***	-0.54***	-0.54***	-0.54***	-0.54***
School-Level Controls									
Percent Male	-0.37	-0.38	-0.45	-0.50	-0.48	-0.43	-0.47	-0.42	-0.42
Percent Minority	-0.86***	-0.90***	-0.89***	-0.78***	-0.89***	-0.90***	-0.84***	-0.85***	-0.89***
Percent Free/Reduced Lunch	0.02	0.02	0.00	0.01	-0.01	-0.01	0.05	-0.01	0.00
Percent LEP	0.95	0.72	0.81	0.79	0.85	1.02	0.77	0.95	0.84
Random Effects									
Variance of School Effects - Year 1	0.06***	0.05***	0.06***	0.06***	0.06***	0.05***	0.06***	0.05***	0.06***
Variance of School Effects - Year 2	0.06***	0.05***	0.06***	0.06***	0.06***	0.06***	0.05***	0.05***	0.06***
Variance of School Effects - Year 3	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***	0.05***
Correlation of Year 1 & 2 Sch. Effects	0.96***	0.96***	0.96***	0.96***	0.96***	0.96***	0.96***	0.96***	0.96***
Correlation of Year 2 & 3 Sch. Effects	0.91***	0.90***	0.90***	0.91***	0.91***	0.90***	0.91***	0.89***	0.91***
Correlation of Year 1 & 3 Sch. Effects	0.84***	0.83***	0.85***	0.85***	0.85***	0.83***	0.84***	0.83***	0.85***
Autocorrelation of Annual Test Scores	0.75***	0.75***	0.75***	0.75***	0.75***	0.75***	0.75***	0.75***	0.75***
Residual Variance	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***

Note. ~p<.10, *p<.05, **p<.01, ***p<.001. Each model also includes fixed effects for the eight grade levels, but these parameters are not shown in this table.

Table 3. Parameter Estimates from Multilevel Models of Student Achievement in Math by Nine Principal Leadership Activities

	Principal Leadership Activity								
Model Parameters	Building Operations	Finance	Parent Relations	District Functions	Student Affairs	Personnel Issues	Planning & Setting Goals	Instructional Leadership	Principal's Professional Growth
Fixed Effects									
Intercept	1.22***	1.18***	1.25***	1.25***	1.29***	1.11***	1.41***	1.40***	1.33***
Year 2	-0.01	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00
Year 3	-0.05	-0.04	-0.04	-0.06	-0.06	-0.04	-0.03	-0.02	-0.05
Average Proportion of Time on the Leadership Activity	0.05	0.13	0.05	0.06	0.02	0.08~	-0.11*	-0.06*	-0.07
Changes in Proportion of Time on the Leadership Activity	0.03~	0.02	-0.02	0.01	-0.01	-0.01	0.00	0.01	0.00
Student-Level Controls									
Male	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***	-0.08***
Minority	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***	-0.44***
Free/Reduced Lunch Eligibility	-0.14***	-0.14***	-0.14***	-0.14***	-0.14***	-0.14***	-0.14***	-0.14***	-0.14***
Limited English Proficiency	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***	-0.28***
School-Level Controls									
Percent Male	-0.70	-0.63	-0.76	-0.85~	-0.79	-0.56	-0.84~	-0.77	-0.71
Percent Minority	-0.91***	-0.95***	-0.96***	-0.86***	-0.93***	-0.96***	-0.89***	-0.97***	-0.93***
Percent Free/Reduced Lunch	-0.17	-0.14	-0.15	-0.16	-0.17	-0.14	-0.12	-0.11	-0.17
Percent LEP	0.69	0.56	0.66	0.79	0.69	0.62	0.70	0.50	0.67
Random Effects									
Variance of School Effects - Year 1	0.04***	0.04***	0.04***	0.04***	0.04***	0.04***	0.04***	0.03***	0.04***
Variance of School Effects - Year 2	0.05***	0.04***	0.05***	0.05***	0.05***	0.05***	0.04***	0.04***	0.05***
Variance of School Effects - Year 3	0.05***	0.04***	0.04***	0.05***	0.05***	0.04***	0.05***	0.04***	0.05***
Correlation of Year 1 & 2 Sch. Effects	0.93***	0.92***	0.93***	0.93***	0.93***	0.93***	0.92***	0.92***	0.93***
Correlation of Year 2 & 3 Sch. Effects	0.89***	0.88***	0.87***	0.88***	0.89***	0.87***	0.88***	0.87***	0.88***
Correlation of Year 1 & 3 Sch. Effects	0.89***	0.87***	0.88***	0.88***	0.89***	0.88***	0.88***	0.87***	0.88***
Autocorrelation of Annual Test Scores	0.77***	0.77***	0.77***	0.77***	0.77***	0.77***	0.77***	0.77***	0.77***
Residual Variance	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***	0.85***

Note. ~p<.10, *p<.05, **p<.01, ***p<.001. Each model also includes fixed effects for the eight grade levels, but these parameters are not shown in this table.