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**Assessing the Contribution of Distributed Leadership to
School Improvement and Growth in Math Achievement**

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Although there has been sizable growth in the number of empirical studies of shared forms of leadership over the past decade, the bulk of this research has been descriptive. Relatively few published studies have investigated the impact of shared leadership on school improvement. This longitudinal study examines the effects of distributed leadership on school improvement and growth in student math achievement in 195 elementary schools in one state over a four-year period. Using multilevel latent change analysis, the research found significant direct effects of distributed leadership on change in the schools' academic capacity and indirect effects on student growth rates in math. The study supports a perspective on distributed leadership that aims at building the academic capacity of schools as a means of improving student learning outcomes.

KEY WORDS: distributed leadership, collaborative leadership, school improvement, student learning, educational change

Over the past 40 years, researchers have sought to understand the contribution that leadership makes to effective schooling (Bossert, Dwyer, Rowan, & Lee, 1982; Firestone & Wilson, 1985; Gross & Herriot, 1965; Hallinger, Bickman, & Davis, 1996; Heck, Marcoulides, & Larsen, 1990; Marks & Printy, 2003). Recent reviews of this literature suggest that substantial progress has been made in understanding both the *extent* of school leadership effects as well as the *means* by which leadership impacts school performance (Bell, Bolam, & Cubillo, 2003; Hallinger & Heck, 1996, 1998; Witziers, Bosker, & Kruger, 2003). One prominent observer recently concluded: "It has become increasingly clear that leadership at all levels of the system is the key lever for reform, especially leaders who a) focus on capacity building and b) develop other leaders who can carry on" (Fullan, 2006, p. 33).

These research findings have brought about two changes in the perspectives of educational researchers and policymakers. First, there is increased interest in how leadership is shared or "distributed" among administrators, teachers, and parents in schools (Gronn, 2002; Leithwood, Mascall, & Strauss, 2009; Spillane, 2006). Scholars now suggest that distributed leadership could provide a more sustainable means of

building the type of learning-focused climate that characterizes high-performing schools (Day, Gronn, & Salas, 2006; Hallinger & Heck, 1998; Leithwood, Anderson, Mascall, & Strauss, In press; Leithwood, Louis, Anderson, & Wahlstrom, 2004; Spillane, 2006).

Second, we note increased interest in the role that leadership plays in bringing about school improvement *over time* (Leithwood et al., 2004; Krüger, Witziers, & Slegers, 2007; Luyten, Visscher, & Witziers, 2005; Reynolds, Teddlie, Hopkins, & Stringfield, 2000; Sammons, Nuttall, Cuttance, & Thomas, 1995; Slegers, Geijsel, & Van den Berg, 2002). Previous research has not adequately addressed the modeling of change in leadership, related educational processes and student learning over time (Heck & Hallinger, 2005; Krüger et al., 2007; Lee, Smith, & Croninger, 1997;). Modeling growth in achievement over time provides one means of assessing the contribution that schools make to the educational progress of students (Seltzer, Choi, & Thum, 2003).

In this article we ask: How does distributed leadership contribute to the improvement of learning in schools? We test a conceptual model in which the effects of distributed school leadership on growth in math achievement are mediated by the school's academic capacity and social-curricular organization. Our proposed analysis of leadership effects differs from previous quantitative work in this field through its focus on measuring organizational variables and student learning on multiple occasions and describing how changes in the initial levels of these organizational variables predict subsequent growth in student learning. Our focus on *changes* in these constructs over a four-year period was intended to confirm a temporal sequence between school actions and student learning.

Our study extends earlier research on leadership and school improvement in two

ways. First, despite calls for studies that examine policy prescriptions for shared leadership against empirical evidence, most studies have been descriptive rather than analytical (Heck & Hallinger, 2005; Leithwood et al., 2009; Pounder et al., 1995). Our study tests a conceptualization of school leadership as an organizational property against empirical evidence of school improvement (Ogawa & Bossert, 1995).

Second, the growth modeling methods used in this study enabled us to monitor changes among the constructs over time. Modeling growth trajectories provides a more thorough and accurate estimation of processes such as student learning than simple comparison of achievement levels at one point in time, learning gains between two measurements, or an achievement score adjusted for a previous score. Growth models incorporate more information about prior conditions than the other approaches (McCaffrey et al., 2004). In growth models, both the level of outcomes attained and the rate of the change over time can be examined simultaneously. This offers greater insight into how *changes* in distributed leadership can contribute to *growth* in student learning.

Prior empirical research on school leadership effects consists almost exclusively of cross-sectional studies that describe these relationships at a single point in time (Hallinger & Heck, 1996; Krüger et al., 2007; Luyten et al., 2005; Southworth, 2002). This approach confounds the effects of time in relationships among variables (Davies, 1994), and is, therefore, ill-equipped to illuminate how leadership contributes to *school improvement* (Jackson, 2000; Leithwood et al., 2004; Ogawa & Bossert, 1995; Pounder, Ogawa, & Adams, 1995). If we are to improve schools in a systematic way, then high-quality information about school processes and outcomes collected over time is essential.

Leadership and School Improvement

One of the challenges of studying school leadership effects is the presence of multilevel organizational structures within educational organizations. Multilevel models of student learning assume that students are not randomly assigned to classrooms, and that principals and teachers are not randomly distributed across schools (Lee & Bryk, 1989). Proposed models must theorize about how educational activities across multiple organizational levels subsequently influence the learning of individual students.

The phrase “school improvement leadership” implies the existence of a cause-effect relationship between the strategies of leaders, school improvement activities, teacher classroom practices, and growth in student outcomes. Although progress has been made in defining the nature of these relationships, scholars operating in the UK (Bell et al., 2003; Southworth, 2002, 2003), USA (Bossert et al., 1982; Hallinger & Heck, 1996, 1998), Canada (Leithwood et al., 2004, in press; York-Barr & Duke, 2004), Netherlands (Krüger et al., 2007; Slegers et al., 2002; Witziers et al., 2003), and AnZed (Mulford & Silins, 2003; Robinson et al., 2008) continue to debate the meaning of empirical findings on school leadership effects.¹ Moreover, the predominant assumption that leadership impacts school improvement understates the extent to which leaders are influenced by the organizational environment (Hallinger & Heck, 1996; Krüger et al., 2007; Leithwood et al., 2004; Southworth, 2002). Thus, we conclude that research on school leadership effects must take into account features of the organizational context and continue to approach issues of causal inference with caution.

Sources of Leadership

The study of school leadership must be explicit about the *sources* of leadership. Although prior research has generally highlighted the leadership role of leadership from the principal, this study focuses on *distributed leadership* (Gronn, 2002; Harris, 2003;

Spillane, 2006). This refers to forms of collaboration practiced by the principal, teachers, and members of the school's improvement team in leading the school's development.

The rationale for distributed school leadership is grounded in the concept of sustainable change (Fullan, 2001). Leadership must create changes that are embraced and owned by the teachers who are responsible for implementation in classrooms (Fullan, 2006; Hall & Hord, 2001). Moreover, given the intensification of work activities of school administrators, selected approaches to leadership must also be sustainable for those who lead (Barth, 1990; Donaldson, 2001). As Hall and Hord (2001) conclude, "principals can't do it alone." Thus, scholars assert that sustainable school improvement must be supported by leadership that is shared among stakeholders (Barth, 2001; Fullan, 2001; Hall & Hord, 2001; Harris, 2003; Marks & Printy, 2003; Stoll & Fink, 1996).

Means of Leadership

We define school improvement leadership as an influence process through which leaders identify a direction for the school, motivate staff, and coordinate an evolving set of strategies towards improvements in teaching and learning. This emphasizes our belief that the effects of school leadership are largely *mediated* by academic and social conditions present in the school, and aimed towards learning outcomes. Empirical evidence, though not conclusive, does provide insight into the *means* by which leaders impact teaching and learning. Specifically, we find that school improvement leadership:

- Impacts conditions that create positive learning environments for students (Geijsel, Slegers, Stoel, & Krüger, 2009; Hallinger et al., 1996; Hallinger & Heck, 1998; Heck et al., 1990; Leithwood et al., 2004, in press; Slegers et al., 2002; Robinson et al., 2008; Wiley, 2001).

- Mediates academic expectations embedded in curriculum standards, structures and processes as well as the academic support that students receive (Cohen & Hill, 2000; Darling Hammond, 2006; Hallinger et al., 1996; Hill & Rowe, 1996; Lee & Bryk, 1989; Oakes, 2005; Secada, 1992).
- Employs improvement strategies that are matched to the changing state of the school over time (Jackson, 2000; Leithwood et al., 2004, in press; Mulford & Silins, 2003; Reynolds et al., 2000; Stoll & Fink, 1996).
- Supports ongoing professional learning of staff which in turn facilitates efforts of schools to undertake, implement and sustain change (Barth, 1990; Crandall, Eiseman, & Louis, 1986; Fullan, 2006; Geijsel et al., 2009; Hall & Hord, 2001; Robinson et al., 2008; Stoll & Fink, 1996).

This description of the *means* by which leadership impacts school improvement is consistent with what scholars have termed a *mediated-effects* model of leadership (Baron & Kenny, 1986; Hallinger & Heck, 1996; Pitner, 1988). Leadership effects on learning are brought about indirectly through its impact on people, structures, and processes in the school (Bossert et al., 1982; Hallinger & Heck, 1996; Leithwood et al., in press).

Modeling Distributed Leadership Effects on Student Learning

In this study, we employ multilevel latent change analysis (LCA), a variant of structural equation modeling (SEM), to examine changes in leadership, school academic capacity, socio-curricular organization, and student math outcomes over a four-year period (see Figure 1). In LCA, linear (and nonlinear) growth can be represented by *initial status* and *change* latent factors (Muthén & Muthén, 1998-2006). Repeated measurements of variables serve as observed indicators of the underlying factors. In LCA

diagrams such as Figure 1, observed variables are delineated by *rectangles*; latent constructs are delineated by *ovals*. After measuring the latent change processes using repeated measures, the second part of the analysis involves examining the structural relationships between the latent change factors and other variables in the proposed model.

Path analytic models are often used to test the plausibility of proposed relationships between variables in non-experimental research (Cook, 2002). The procedure can be formulated as an estimation of the coefficients of a set of simultaneous equations representing the proposed relationships (Jöreskog & Sörbom, 1989). The process involves imposing a set of model restrictions on the sample covariance matrix and trying to determine whether the proposed set of model restrictions, or an alternative set, fits best in the population under study. In formulating path models, researchers often draw a distinction between *exogenous* variables (i.e., explanatory variables whose variability is accounted for by factors outside of the model) and *endogenous* variables (i.e., variables whose behavior is dependent upon other variables within the model). The goal is to solve the equations for endogenous variables taking into account the exogenous variables and random errors between constructs. In Figure 1, we show the exogenous variables as *unshaded* rectangles or ovals and the endogenous factors as *shaded* ovals.

Insert Figure 1 About Here

Exogenous Variables

Within schools, we include student background as a set of exogenous variables that are proposed to explain a portion of student growth in math. At the school level, the model includes several context variables that scholars have identified as affecting leadership and student achievement: school size, student composition, principal stability,

as well as teacher professional preparation, certification, and stability (Goldhaber, 2002; Hallinger & Murphy, 1986; Leithwood et al., 2004; Southworth, 2002; Teddlie, Stringfield, & Reynolds, 2000). In addition to its direct effect on achievement, student composition (e.g., social class, race/ethnicity, language background) has been found to affect academic expectations, curriculum organization, grouping, and teacher behavior (Lee & Bryk, 1989; Oakes, 2005). Features of small schools appear to favor enhanced growth in student learning (Leithwood et al., 2004; Mulford & Silins, 2003; Southworth, 2003). In Figure 1, the large arrow from context and structure indicates that we expect these to influence other variables in the model, although we do not hypothesize their specific effects in the study.

In our model, “staffing” is also considered as a set of exogenous indicators. Teacher certification information and staff stability are potentially important because previous research has found that schools in communities serving concentrations of low SES and students of color have greater difficulty hiring and retaining quality faculty and administrators (Darling Hammond, 2006; Goldhaber, 2002). Contextual inequities can compromise the quality of student learning outcomes (Oakes, 2005; Shields et al., 1999). Previous research also indicates that principal stability can influence the management of school improvement projects (e.g., Firestone & Wilson, 1985). In Figure 1, the large arrow from staff quality and stability suggests that staffing variables will affect the endogenous constructs in the model positively (e.g., socio-curricular organization, change in achievement, change in academic capacity).

Endogenous Variables

In the model, the endogenous variables serve as mediating organizational

processes between the exogenous variables and growth in student math outcomes. In Figure 1, we conceptualize four endogenous variables: change in distributed leadership, change in school academic capacity, socio-curricular organization (measured in year 4 of the study), and change in math achievement. The first, change in distributed leadership, has been discussed in the previous section.

The second variable, change in school academic capacity, refers to changes in conditions of the school that support the provision of effective teaching and learning and enable the professional learning of the staff (Cohen & Hill, 2000; Darling Hammond, 2006; Hallinger & Heck, 1998; Hill & Rowe, 1996; Robinson et al., 2008; Stoll & Fink, 1996). In Figure 1, we propose that changes in academic capacity will positively affect school socio-curricular organization and growth in student learning. In Figure 1, we highlight this leadership-academic capacity portion of the model in gray in order to emphasize our focus on these constructs as representing a mutually-reinforcing process.

Variables are mutually reinforcing if each leads to change in the other (Marsh & Craven, 2006). More specifically, the leadership-academic capacity portion of the model represents two parallel growth processes (see Muthén & Muthén, 1998-2006, for further discussion). Our model implies that the leadership and capacity-building growth trajectories found in schools (and the math achievement trajectories of individual students within schools) have common algebraic forms, but that not every school has the same trajectory (Singer & Willett, 2003).

A third mediating factor is the school's socio-curricular organization (Goldhaber, 2002; Lee & Burkam, 2003; McCaffrey, Lockwood, Koretz, & Hamilton, 2003). An extensive literature describes how schools' socio-curricular organization impacts student

learning opportunities and educational attainment (Alexander & Cook, 1982; Braddock & Slavin, 1993; Burns & Mason, 1998; Cicourel & Kitsuse, 1963; Lee & Bryk, 1989; Oakes, 2005). In models of school effects, the socio-curricular organization of the school mediates between contextual (e.g., social composition) and structural conditions (e.g., enrollment, type of school) and student outcomes (Lee & Burkam, 2003). Lee and Burkam define curricular organization as students' access to quality academic experiences within the school. Social organization refers to the pattern of social relationships among administrators, teachers, and students (e.g., presence of supportive relationships, student integration and well being). Within classrooms, individual students benefit from positive relationships with teachers (Fullan, 2001; McCaffrey et al., 2004). At the school level, teacher expertise and patterns of teacher-student interactions tap into the quality of socio-curricular relations (Lee & Burkam, 2003; Oakes, 2005).

If academic capacity is a key target of leadership efforts designed to impact teacher practice and student performance, then, as Figure 1 suggests, we propose that changes in school academic capacity should be reflected in student perceptions of the school's classroom curriculum and social relationships between students and teachers. Moreover, we propose students' perceptions of their socio-curricular relationships with teachers will be positively related to growth in achievement.

The fourth endogenous variable is math achievement. We represent student growth in math at two organizational levels [i.e., the student and school levels] and propose that students' growth in math is a parameter that varies randomly across schools. This implies that student growth rates are different within the population of schools. The subsequent objective is to explain this variability in growth rates through the contextual and organizational variables proposed in the model.

Classrooms represent an organizational level that mediates the effects of school-wide improvement activities on individual student progress. We note that this multilevel study does not include a direct measure of change in the instructional practices of teachers (shown as a dotted, shaded oval in Figure 1). While we acknowledge that classroom-level would be desirable in order to provide a more complete picture of the organizational processes at work in these schools, such data is exceedingly difficult to come by. Indeed, none of the ‘gold standard studies’ conducted in this field have included such data (e.g., Hallinger et al., 1996; Heck et al., 1990; Pounder et al., 1995; Leithwood, 1994; Leithwood & Jantzi, 1999; Marks & Printy, 2003; Wiley, 2001)

Nonetheless, we must be explicit that we are *assuming* that changes in school leadership and capacity building processes exert “trickle down” cross-level effects on teacher classroom behavior (implied in Fig. 1 by a dotted arrow from unmeasured changes in classroom practices to student growth rates). These, in turn, will contribute to variability in student growth rates (Cohen & Hill, 2000; Creemers, 1994; Heck, 2009; Hill & Rowe, 1996). While the inability to directly test this assumption represents a limitation of the study, we do report the results of comparing teacher perceptions of changes in classroom practices against students’ perceptions of the same classroom changes. In related research conducted on this data, we also determined that differences in the effectiveness of successive classroom teachers (accounting for about 11% of the total variability in math outcomes) and the school’s collective teaching effectiveness contribute meaningfully to reducing gaps in student learning in math between schools. We place this limitation in perspective in the concluding section of the article.

Research Questions

We propose two broad research questions in this study. The questions are framed within the conceptual model proposed above and portrayed in Figure 1.

What is the relationship between distributed leadership and academic capacity when observed over time? We assert that school improvement represents a dynamic process that involves changes in the state of the organization over time. Our model proposes that changes in distributed leadership and academic capacity represent a mutually-reinforcing process. Initial distributed leadership is proposed to be positively related to change in school academic capacity, and initial academic capacity to change in distributed leadership.

How does distributed leadership impact school improvement capacity and subsequent growth in math? The second question seeks to illuminate how *changes* in levels of distributed leadership and academic capacity carry over to *changes* in math achievement. We propose that school academic capacity and socio-curricular organization function as mediators between distributed leadership and student growth. We assess the strength of the mediated effects (and indirect leadership effects) in accounting for growth in student learning (Calsyn et al., 2005). We test several propositions in relation to this question.

First, we propose that change in distributed leadership will be *directly* and significantly related to change in academic capacity. Second, we propose that changes in academic capacity will be *directly* and significantly related to (a) growth in student learning and to (b) student perceptions of socio-curricular organization. Third, we also propose that change in distributed leadership will be *indirectly* and significantly related to change in socio-curricular organization and math achievement. Finally, we propose that change in distributed school leadership will be contingent on student composition and principal stability.

Research Method, Data, and Measures

This study employs a longitudinal non-experimental design (Campbell & Stanley, 1966). Longitudinal non-experimental studies are often used to study developmental trends (Marsh & Craven, 2006). Although superior to cross-sectional designs when temporal relationships are a focal point of the analyses, they do not fully resolve issues of causal direction between variables (Cook, 2002). The major threat to validity in longitudinal non-experimental research lies in uncontrolled or confounding variables.

To test the model, data were collected from students and teachers in elementary schools in a western state in the USA over a four-year period. We captured changes in school processes through surveys given to each school's teachers on three occasions (years one, three, and four). Return rates for the three periods were 73.4% (N = 3,911), 78.6% (N = 4,152), and 76.2% (N = 4,055), respectively. The survey is administered at regular cycles in each school to all certified staff, grade five students, and a random sample of parents (i.e., about 20% across grade levels in each school). Where surveys are repeated over time with a high level of consistency between items, the measures may be used to estimate changes in a population [i.e., referred to as a longitudinal panel study (Davies, 1994)]. Achievement data from a student cohort were collected in years two, three and four (i.e., corresponding to their third, fourth, and fifth grade years). Unequal spacing of observations and nonlinearity can be incorporated into a LCA model without compromising quality of data analysis (Raykov & Marcoulides, 2006).

Data

Data were from a random sample of public elementary schools (N = 195). From these schools, participating students were drawn from a third-grade student cohort (N = 13,389) that was subsequently observed over a three-year period (i.e., third through fifth

grades). Background data were as follows: female, 49%; participation in federal free/reduced lunch program, 45%; receiving English language services, 7%; receiving special education services, 11%; minority, 50%, and changed schools, 16%. One of the advantages of growth modeling is that missing data (i.e., less than 5%) and student mobility can be incorporated directly into the analysis, which reduces parameter bias that would result from eliminating these students (Peugh & Enders, 2004).

Measures

The conceptual model described earlier was operationalized through explicit measurement of the exogenous and endogenous variables included in Figure 1.

Background and context variables. Background variables included female (coded 1, male coded 0), low socioeconomic status (i.e., participation in the federal free/reduced lunch program coded 1, else coded 0), special education services (coded 1, else coded 0), minority by race/ethnicity coded 1, else coded 0), English language learning (ELL) services (coded 1, else coded 0), and changed schools (coded 1, else coded 0).

At the school level, context and structural indicators describe initial school contexts during the first year of the study (2002-03). *Student composition* was defined as a composite variable by combining several relevant student demographics to create a weighted school indicator (using principal components analysis). The variables included percentage of children receiving free or reduced lunch, percentage of students receiving English language (ELL) services, and the percentage of racial/ethnic minority students. Larger positive values represent schools where percentages of these students were higher. *School size* was defined as the number of students enrolled for the school year.

Staffing variables. *Teacher quality* was defined as the percentage of teachers at

each school who met No Child Left Behind (NCLB) and state teacher licensing criteria. *Teaching staff stability* was defined as the percentage of teachers in each school who had been at the school for five years. We assessed both of these staffing variables during year four of the study. Given that principals typically play an important role in hiring decisions, the validity of this assumption warrants some further discussion. Since NCLB was implemented, the state has tracked percentages of fully-qualified teachers. Data on teacher qualifications between 2003 and 2006 suggest that local teacher labor market conditions continued to necessitate hiring considerable percentages of teachers who were less than fully qualified.² *Principal stability* was defined as whether the same principal (coded 1, else 0) was at the school during the four years of the study. Descriptive statistics for exogenous variables are included in Table 1. We note that about 31% of the principals were in the same school over the length of the study and roughly 60% of the teachers. About 84% of the teachers met all state licensing criteria.

Insert Table 1 about Here

Distributed leadership and academic capacity. For the purposes of this study, information from three successive teacher surveys was used to measure these two variables. Items defining the constructs were measured on five-point, Likert-type scales. Higher item means reflect stronger agreement with the items defining each subscale. Cronbach's (1951) alpha (α), a measure of internal consistency, was used to assess the reliability of each subscale.

Distributed leadership was measured by a composite set of items describing teacher perceptions of leadership exercised from a variety of sources within the school ($\alpha = 0.82$). The stem used for these items was "To what extent does school leadership...."

The state survey items were designed to reflect three specific aspects of distributed leadership within each school (with items paraphrased in parentheses):

Make collaborative decisions focusing on educational improvement (i.e., Ensure teachers have a major role in decisions about curriculum development in the school; Enable administrators, teachers, and staff work together effectively to achieve school goals);

Emphasize school governance that empowers staff and students, encourage commitment, broad participation, and shared accountability for student learning (i.e., Provide opportunities for parents to participate in important decisions about their children's education through a variety of venues; Ensure teachers can freely express input and concerns to the administrators; Provide opportunities for teachers to plan and make school decisions;); and

Emphasize participation in efforts to evaluate the school's academic development (e.g., Ensure adequate resources are available to the school to develop its educational programs; Provide regular opportunities for all stakeholders to review the school's vision and purpose).

Observed leadership scores for each measurement occasion (i.e., Lead1, Lead3, Lead4, in Figure 2) were used to define the leadership factor. Positive growth in leadership over time results when teachers give higher scores on the leadership subscales.

School academic capacity ($\alpha = 0.94$) was measured by four subscales:

Standards emphasis and implementation ($\alpha = 0.91$). School's educational programs are aligned to the State content and performance standards; teaching and learning activities are focused on helping students meet the State content and

performance standards; school prepares students well for the next school; students and parents are informed about what students are expected to learn; school has high academic and performance standards for students; classroom instruction includes active participation of students; curriculum and instructional strategies emphasize higher-level thinking and problem solving; instructional time is flexible and organized to support learning; teachers provide a variety of ways for students to show what they have learned; students learn to assess their own progress and set their own learning goals; students are provided with multiple ways to show how well they have learned; homework assignments are appropriate, productive, and reflective of adopted learning standards; assessment results are used to plan and adjust instruction;³

Focused and sustained action on improvement ($\alpha = 0.83$). The school clearly communicates goals to staff, parents and students; vision and purpose are translated into appropriate educational programs for children; school seeks ways to improve its programs and activities that promote student achievement; teachers know what the school learner outcomes are; teachers expect high quality work; school's vision is regularly reviewed with involvement of all stakeholder groups; changes in curriculum materials and instructional practices are coordinated school-wide and I am involved in the school improvement process;

Quality of student support ($\alpha = 0.85$). Standards exist for student behavior; discipline problems are handled quickly and fairly; school environment supports learning; open communication exists among administrators, teachers, staff, and parents; teachers feel safe at school; teachers and staff care about students; administrators, teachers, and staff treat each other with respect; I provide students with extra help when they need it;

programs meet special needs of students; school reviews support services are offered to students;

Professional capacity of the school ($\alpha = 0.80$). Teachers are well qualified for assignments and responsibilities; leadership and staff are committed to school's purpose; staff development is systematic, coordinated, and focused on standards-based education; systematic evaluation is in place.

Preliminary analyses determined how well the four indicators defined the latent academic capacity factor at each measurement occasion. Factor loadings across occasions averaged 0.94, 0.91, 0.96, and 0.92, respectively. This suggests the scales were strong measures of the underlying academic capacity factor. Factor scores for each occasion (i.e., Capacity1, Capacity3, Capacity4, in Figure 2) were saved as variables and used in subsequent analyses. Positive growth in capacity over time means that teachers assigned higher scores on the subscales comprising academic capacity at succeeding occasions.

Socio-curricular organization. Socio-curricular organization was defined by fifth-grade student perceptions of the quality of their social relationships with teachers (and other adults) in the school as well as by their experience of academic-curricular processes. We obtained these measures in Year 4. The subscale alphas and items of the two subscales are as follows.

Social organization ($\alpha = 0.92$) consists of 7 items (i.e., I can freely express my opinions or concerns to my teachers; I can talk to my teachers, counselors, or other adults at school when I need to; My teachers care about me and treat me with respect; Students get along with each other pretty well at my school; My teachers give me extra help when I need it; I get help from the counselor when I need it; I enjoy coming to school).

Curricular organization ($\alpha = 0.94$) consists of seventeen indicators of student perceptions about their classroom processes (i.e., School work is challenging; What I am learning will help me in the next grade; The programs at my school are good; What I am learning helps me reach the content and performance standards; My homework assignments help me to learn better; My teachers teach me how to think and solve problems; most of my teachers teach in a way that is clear and easy to understand; My teachers make learning interesting in different ways; If I am having trouble learning something, my teachers usually find another way to help me understand it; We learn by doing things, not just by sitting and listening; I have learned to evaluate my own work and keep track of my progress; Students can show what they have learned in different ways—projects, portfolios, presentations; My teachers tell me how I am doing and how I can improve; I am aware of how well I am doing in class; My teachers discuss my progress in class with me on a regular basis; My teachers explain to me what they want me to learn; My teachers expect me to do quality work).

Math achievement. The math test used in the study was constructed to measure state-developed math content standards. The test consisted of constructed-response items and standardized test items from the Stanford Achievement Test (Edition 9). The test assesses student learning in five strands (number and operation; measurement; geometry and spatial sense; patterns, functions and algebra; and data analysis, statistics, and probability) consisting of 52 items. Student scores (re-scaled to range from 100 to 500) considered patterns of right, wrong, and omitted responses over successive years and were equated across the three years to enable the measurement of academic growth.

Data Analysis

Our proposed model highlights several features of data that must be incorporated

into the analysis. First, the analysis must reflect the multilevel, nested structure of schools (Ogawa & Bossert, 1995). Accurate estimation of school parameters requires adjustment for the clustering of students within schools (Hill & Rowe, 1996). Second, repeated observations describing changes in individual students or changes in schools over time also represent nested data structures. This requires an analytic approach capable of incorporating changes in several variables at multiple organizational levels in one simultaneously-estimated model (Singer & Willett, 2003). Third, longitudinal models require the specification of a temporal sequence of relationships among variables. In our study, relationships between prior and subsequent conditions are conceived as dynamic and possibly mutually reinforcing (Marsh & Craven, 2006). Our approach to multilevel, longitudinal modeling enables representation of initial states of variables and subsequent changes that occur between them over time. Fourth, in the context of testing proposed structural equation models, we recognize the need to consider alternative explanations and interpretations of our findings. Caution should therefore be exercised in using SEM applications to test substantive theories. Omitted variables and measurement error are common sources of model misspecification that can produce misleading results (Bentler & Bonett, 1980). More specifically, there may be unmeasured exogenous or endogenous variables that may be correlated with major constructs, such as leadership, in our model. These could compromise the validity of our proposed model. We next describe some of the steps we took to lessen this likelihood.

Preliminary analyses. We conducted several preliminary analyses to investigate possible relationships between exogenous school and staffing indicators which might influence our results (not tabled). For example, we found teaching staff stability was positively, but weakly, correlated with principal stability ($r = 0.18$) and the percentage of

fully-qualified teachers comprising the staff ($r = 0.32$). Because principals exercise influence in hiring teachers, we also investigated how school conditions might influence patterns of teacher mobility over time. We estimated that teacher turnover averaged about 8% per year during the years of our study. We also noted that the total set of school (i.e., student composition, student achievement, enrollment size) and staffing conditions (i.e., teacher, principal stability, teacher experience) included in our model contributed little (about 1%) in explaining school changes in percentages of fully-qualified teachers over the years of the study (not tabled).⁴

Testing the proposed model. We next turned our attention to testing our proposed model in several steps. The indices describing the fit of each model to the data are summarized in Table 3. In LCA, repeated observations on individuals over time (y_t) can be expressed as a measurement model where the intercept and growth latent factors are measured by the multiple indicators of y (see end note for further details).⁵ The intercept factors representing the constructs were defined to represent initial achievement, leadership, or academic capacity, which is accomplished by setting each factor loading to 1.0 (as shown in Figure 2). The growth factors were defined to incorporate possible nonlinearity in the growth trajectories. This was accomplished by fixing the first factor loading for measurement occasion to 0, the second occasion to 1, and letting the third factor loading be estimated by the software. The freely-estimated relationship for each latent growth factor is represented by an asterisk in Figure 2 in the Results section. The size of the estimated factor loading determines the shape of the growth trajectory (Raykov & Marcoulides, 2006).

Partitioning the variance in growth into its within- and between-group components is an important first step in determining whether a multilevel analysis is

justified. If sufficient variance in growth rates exists *between schools* (e.g., over 5%), a school-level model can be developed to explain variability in this portion of the outcome. Our “variance components” model (Model 1 in Table 2) also examined the means and variability in the other endogenous factors. This first model does not include predictors.

Model 2 investigated the direct relationships between the context variables and math growth. Student-level variables were centered on their grand means. This results in school means that are adjusted for differences between students. This provides a more equitable comparison between schools in terms of what they contribute to growth in student learning. School-level estimates were also centered on their grand means (except for the dichotomous indicator of principal stability).

Model 3 added the mediating distributed leadership and academic capacity growth factors to the model. Model 4 added the mediating social-curricular organization latent variable to the model. This factor was defined by two scales: social and curriculum organization. Adding this mediating variable to the model allowed us to examine whether the school organization construct might diminish or eliminate any direct effect of change in academic capacity (and indirect effect of leadership) on student growth in math. For example, if this variable eliminated the influence of the other key change constructs on school growth rates, it would invalidate our proposed model of school improvement. The between-school parameter estimates for Model 4 are summarized in Figure 2.

Investigating specific propositions. Finally, we tested the validity of our model by examining two specific propositions about paths in the model. These tests are summarized in Table 2. More specifically, we investigated an alternative model (Model 5) with a structural path from change in academic capacity to change in leadership

instead of from change in leadership to change in capacity (as in Model 4). We also compared the fit of our proposed model of *indirect* leadership effects on math outcomes (through academic capacity) against a more general model that proposed both a *direct* effect and an *indirect* leadership effect on outcomes (Model 6). Such tests explore the validity of a proposed model and, in this case, the test was conducted by estimating an additional path between change in leadership and growth in math. We then compared the subsequent change in chi-square ($\Delta\chi^2$) between the two models after appropriate scaling adjustment for non-normality (Muthén & Muthén, 1998-2006).

Results

Evaluating Alternative Models

Tests of our proposed model were conducted with Mplus 5.2 (Muthén & Muthén, 1998-2006). We present results based only on the series of models we originally proposed. In testing models using SEM, the emphasis is on specifying a set of theoretical relationships before testing them against the data. The goal is to reproduce the original matrix of covariance relationships with a set of model-proposed restrictions placed on it. In testing models, if a proposed model does not fit the data well, it would have to be reconceptualized. In contrast, if a proposed model fits the data well, this implies that it is a plausible representation of the data; but, it may not be the only plausible representation (Hoyle & Panter, 1995).

In practice, one may not have only one model (or set of restrictions) in mind, but rather, a series of competing models. Testing the adequacy of each proposed model in sequence is known as an alternative-models approach (Hoyle & Panter, 1995). Through these comparisons one can determine whether the alternative models fit the data as well, better, or worse than the primary model.

Models are evaluated in terms of their substantive features and the adequacy of their fit against the data. The adequacy of fit of each proposed model to the data, summarized in Table 2, was determined by several model fit indices. Although the chi-square statistic is often used in evaluating models, it has the undesirable property of being affected by sample size. With large samples, this can lead to falsely rejecting proposed models that otherwise fit the data quite well (Raykov & Marcoulides, 2006). In order to address this limitation, we also report the Root Mean Square Error of Approximation (RMSEA) fit index and the Comparative Fit Index (Raykov & Marcoulides, 2006). RMSEA describes the amount of model discrepancy per degree of freedom in the model. Values near 0.05 or lower generally indicate an adequate fit of the model to the data. The CFI compares the fit of the proposed model against a baseline (non-fitting) model, with values of at least 0.95 providing evidence of an adequate model fit.

The model fit criteria in Table 2 suggest each proposed model provided an adequate fit to the data (e.g., CFI above 0.95, RMSEA below 0.02). The table also provides an estimate of the variance in student growth accounted for by each model that includes predictors (Models 2-4). Model 2, which consisted of context and staffing variables, and initial achievement status, accounted for about 75% of the between-school variance in math growth. Model 3, which added the mediating leadership and academic capacity factors, accounted for an additional 11% of the growth variance. Model 4, which added the social and curriculum organization construct, accounted for an extra 2% of variance in growth (total $R^2 = 88\%$). Thus, models 2-4 accounted for substantial amounts of variance in school math growth.

Insert Table 2 About Here

Because model testing revealed a strong fit to the data, we can turn our attention to the specific parameter estimates in our proposed models. We begin by discussing the means and variability in the endogenous factors as specified in our variance components model (Model 1). In Table 3, between schools, the math growth variance component was 310.11. Within schools, the individual factor variance in math growth was 2110 (not tabled). This suggests about 13% of the variability in latent growth lies *between schools* [$310/(2110 + 310)$]. This implies that the proposed model may be useful in explaining differences in math growth rates between schools. Data in the table further suggest there was significant variance in math growth ($\sigma_M^2 = 310.11, p < .01$) in the population.

Insert Table 3 About Here

Turning to the leadership and academic capacity factors, the results in Table 3 indicate there was significant variability in both initial status means and growth means across schools in the population. The initial leadership mean was -0.01; this reflects the year-1 average leadership mean, which is centered on the grand mean for the schools in the sample. Table 3 indicates there was significant variability in initial levels of leadership across schools ($\sigma_{IL}^2 = 0.020, p < .01$). The leadership growth slope was 0.00 (i.e., -0.004), which because of our coding scheme, can be interpreted as the average change in leadership between the first and second intervals of the study (i.e., year 1 and year 3). There was also significant variability in leadership growth slopes across schools ($\sigma_{SL}^2 = 0.003, p < .05$).

Similarly, the initial academic capacity factor mean was -0.03, and the mean academic capacity growth slope was 0.01. Again, this suggests there was little average change in the academic capacity of schools between the first and second intervals of data

collection (i.e., year 1 to year 3). At the same time, however, Table 3 also suggests that initial academic capacity levels and average change in capacity varied significantly across schools ($p < .01$). These results indicate that there was observed variation in the leadership and academic capacity change trajectories of individual schools.

Distributed Leadership Effects on School Improvement

The next portion of the analysis focuses on explaining variability in the endogenous factors. Model 4 summarizes our proposed Figure 1 model with indirect effects of distributed leadership on growth in math. Figure 2 portrays the effects of the school-level exogenous and endogenous variables on math growth in Model 4. We first examine the trajectories for the latent growth factors. For math growth, the third occasion in Figure 2 was estimated as 2.0. This suggests a linear growth trajectory, since the growth rate between each occasion was 1.0. In contrast, for growth in capacity, the third occasion was estimated as 1.6, which suggests decelerating growth between the second and third occasions, compared with the first and second occasions. For change in leadership, the third estimate was 4.1, which suggests the trajectory has a quadratic shape (i.e., increasing between occasions 1 and 2, but declining between occasions 2 and 3).

We note in passing that all of the student background variables were significantly related to *growth rates* in math.⁶ The coefficients in Figure 2 are standardized, which indicates the relative size of each variable's effect (the significance level was set at $p = 0.05$). When interpreting effect sizes, the level of analysis matters in multilevel populations. For example, a standardized effect that is small in accounting for existing variation at the student level (e.g., 0.1 or 0.2) may be large in accounting for between-school variation (Bloom et al., 2008). Between schools, students' yearly math growth rate was about 0.5 of a standard deviation (not tabled). A between-group effect of 0.2,

therefore, would increase the yearly growth rate by about 40% (Bloom et al., 2008). It is therefore best to consider specific effects in relation to others at each level of the model.

Insert Figure 2 about Here

With respect to the school context, structure and staffing variables, student composition (standardized $\gamma = -0.20, p < .05$), teacher professional preparation (standardized $\gamma = 0.12, p < .05$), and school size (standardized $\gamma = -0.10, p < .05$) were significantly related to math growth rates. Regarding the endogenous factors, both change in school academic capacity (standardized $\gamma = 0.18, p < .05$) and school organization (standardized $\gamma = 0.09, p < .05$) were significantly related to math growth rates. Staff stability (standardized $\gamma = 0.43, p < .05$) and teacher professional quality (standardized $\gamma = 0.22, p < .05$) were also significantly related to school social/curricular organization, but not to change in leadership or improvement capacity. Next we examine the two research questions posed for this study.

What is the relationship between distributed leadership and academic capacity when observed over time? This question examined proposed relationships among variables in the model in terms of their initial levels and subsequent levels. The results provide support for our first proposition that the initial level of distributed leadership in the school would be related to subsequent change in academic capacity (standardized $\gamma = 0.14, p < .05$). Similarly, initial level of academic capacity was significantly related to subsequent change in distributed leadership (standardized $\gamma = 0.19, p < .05$). Coding of the growth factors in the model (0, 1, * in Figure 2) proceeded with factor loading for the third interval freely estimated. Therefore, the coefficients can be interpreted as the amount of change between year 1 and year 3 per one standard-deviation increase in the

levels of the initial factors. This implies that a 1-SD increase in initial leadership would yield a 0.14 SD increase in the academic capacity growth rate between years 1 and 3. Similarly, a 1-SD increase in initial capacity would yield about a 0.19 standard deviation increase in the leadership growth rate between years 1 and 3.

How does distributed leadership impact school improvement capacity and subsequent growth in math? This question focused on the effects of changes in distributed leadership and capacity building (as perceived by teachers and students) and learning outcomes over the four-year period. First, we proposed that change in distributed leadership would be *directly* and significantly related to change in schools' academic capacity. Since leadership is often seen as a *catalyst* for change, we hypothesized that stronger perceptions of leadership would be associated with increased academic capacity. As proposed, we found change in distributed leadership was strongly and significantly related to change in academic capacity (standardized $\gamma = 0.46, p < .05$). We tested whether the proposed path might instead be in the other direction (i.e., from change in capacity to change in leadership), but found that Model 4 was superior (see Model 5 in Table 2).

Second, we proposed that changes in academic capacity would be *directly* and significantly related to (a) socio-curricular organization and (b) growth in student learning. We found that change in academic capacity and student growth rates in math was also significant and substantial (standardized $\gamma = 0.18, p < .05$). We noted that this relationship was somewhat stronger (0.26, not tabled) before socio-curricular organization was added to the model. Controlling for socio-curricular organization, then, was useful in estimating the size of the effect associated with changing academic capacity on student growth more accurately. We also found that changes in academic capacity were positively related to changes in socio-curricular organization (standardized $\gamma = .20$,

$p < .05$) and that socio-curricular organization was positively related to growth in math (standardized $\gamma = 0.09, p < .05$).

Our third proposition stated that the combined effects of distributed leadership on student growth rates in math would be *indirect* rather than direct. The indirect effect of change in distributed leadership (mediated by change in academic capacity) on school organization was significant (standardized $\gamma = 0.09, p < .05$, not tabled). Although the size of the indirect effect of distributed leadership on student growth in math may appear small, it is on a par with the direct effects of other variables in our model (i.e., teacher professional preparation and school socio-curricular organization) known from previous studies to affect learning outcomes (e.g., Betts et al., 2000).

Comparison of effect sizes among school-level variables may be a more accurate means of judging the size of school effects than simply adopting language such as *small* or *medium* to describe them (Bloom et al. 2008). More specifically, standardized effects of 0.1 would increase school growth rates by about 20% ($0.10/0.50$), and standardized effects of 0.2 would increase school growth rates by about 40% (see Bloom et al., 2008). As Table 2, suggests, Model 4 accounted for an additional 13% of the total variance in math growth above the Model 2 variables. The total variance accounted for in school growth in math was 88%, with 12% from other sources (in parentheses in Figure 2).

We also tested the validity of the proposed model against a model incorporating both *direct* and *indirect* leadership effects on achievement. This alternative model included one more parameter representing the direct path between change in distributed leadership and math growth rates (see Fig. 2). The model with both indirect and direct effects (Model 6 in Table 2) was less accurate than the model with only indirect effects

(adjusted for non-normality, $\Delta\chi^2 = 0.06, p > .05$) with $\Delta df = 1$). Moreover, the estimate of direct leadership effects on learning was not significant (standardized $\gamma = 0.01, p > .10$, not tabled). We therefore accepted the indirect leadership effects model (Model 4 in Table 3) as a more parsimonious representation. This is relevant to the ongoing theoretical issue of whether leadership effects on school improvement outcomes should be conceptualized as indirect only or both direct and indirect.⁷

Finally, we proposed that selected context variables could moderate the exercise of school improvement leadership. This analysis examined whether the model of leadership effects on school improvement might vary systematically across different types of school settings. Figure 2 indicates only a few significant effects of context variables on change in distributed leadership and change in academic capacity. More specifically, in schools where the same principal was present over the period of the study, teachers reported a more capacity-building in distributed leadership over time (standardized $\gamma = 0.22, p < .05$). Student composition did not affect change in distributed leadership (standardized $\gamma = 0.06, p > .10$, not tabled). When we added an interaction of these two variables (principal stability*composition), it was not significantly related to perceptions of change in leadership (standardized $\gamma = -0.05, p > .05$, not tabled). Although student composition was related to perceptions of change in academic capacity (standardized $\gamma = -0.26, p < .05$), principal stability was not.

Discussion

This paper builds on a substantial body of research that has explored the effects of leadership on school improvement and student learning (Hallinger & Heck, 1996, 1998; Leithwood et al., 2004, in press; Robinson et al., 2008). Initially, we highlighted two

limitations of this knowledge base that this study sought to address: a lack of 1) empirical research on the effects of distributed leadership and 2) longitudinal research that examined leadership effects on school improvement over time. In this section, we summarize the findings, review limitations of the research, and outline the implications.

First, we proposed that the relationship between distributed leadership and academic capacity was dynamic and possibly reciprocal. The limitations of viewing leadership solely as *the causal factor* in school improvement change have been amply discussed in the literature (e.g., Pitner, 1988; Hallinger & Heck, 1996; Kruger et al., 2007; Luyten et al., 2005; Witziers et al., 2003). In this report, we employed a multidimensional perspective that focused on several aspects of school organization hypothesized to influence growth in student learning. Since these constructs are not readily amenable to experimental manipulation, we relied on longitudinal panel data, in which the key constructs proposed to drive school improvement were measured on multiple occasions over a four-year period (Cook, 2002; Marsh & Cravens, 2006).

We found support for the hypothesis that leadership and capacity building are mutually reinforcing in their effects on each other, and exercise a cumulative impact on student learning. This reciprocal effects model of school improvement is underpinned by the notion that in settings where people perceive stronger distributed leadership, schools appear better able to improve their academic improvement capacity. Similarly, where academic capacity is perceived to be stronger at one point in time, this appears to contribute to the development of stronger leadership over time.

Second, we found that changes in these mutually-reinforcing constructs were also positively associated with school growth rates in math. The effect size for change in

academic capacity was almost 0.2. This implies that an increase of 1-SD in academic capacity was associated with an increase in the average school growth rate of almost 40%. This finding of *indirect* leadership effects on *math growth rates* extends an important conclusion from previous cross-sectional research (Bell et al., 2003; Hallinger & Heck, 1996; Leithwood et al., 2004; Robinson et al., 2008; Witziers et al., 2003).

The focus on distributed school leadership is of theoretical interest and practical importance. Up to now, the literature on distributed leadership has emphasized conceptual development (Gronn, 2002) and description of distributed leadership practices (Leithwood et al., 2009; Spillane, 2006). Our findings represent an early contribution to the emerging *empirical* knowledge base on the *effects* of distributed school leadership (e.g., Marks & Printy, 2003; Mulford & Silins, 2003; Pounder et al., 1995). The study highlights additional sources of school leadership and explicitly links distributed leadership to capacity building strategies designed to impact teaching and learning.

Our findings imply the need to distribute particular types of leadership practices and create a sustained focus on strategies aimed at the improvement of teaching and learning (e.g., fostering curricular standards and alignment, developing instruction, providing tangible support for students, improving professional capacity, sustaining a focus on academic improvement). Unfortunately, given limitations in measurement of the leadership construct, our results offer little direct insight into which leadership practices should be distributed or how they should be distributed among different staff roles.

Third, the results also suggested that changes in perceptions of distributed leadership and academic capacity were significantly related to student perceptions of the quality of the school's socio-curricular organization. This relationship supports the

validity of our school improvement model because the data came from different sources. Moreover, even after adding this additional mediating variable to our proposed improvement model, both leadership and academic capacity effects remained significantly related to math growth rates (although slightly diminished).

Finally, although this study did not explicitly measure the contribution of *principal leadership* to building academic capacity, *principal stability* demonstrated a small, but statistically significant, positive effect on teacher perceptions of *changes in distributed leadership*. In schools where the same principal was present over the course of the study, there was a significantly stronger perception of academic capacity at the end of the four years.

One possible interpretation of this finding is that successful principals tend to stay longer at their schools. Another is that the principal's leadership role may remain important even when schools are seeking to develop a broader capacity for leadership. As some theorists have speculated, supportive leadership from the principal may well represent a necessary (but not sufficient) condition to developing the capacity among other school leaders (Barth, 1990, 2001; Fullan, 2001; Leithwood et al., 2009).

Limitations

These findings should be interpreted in light of several limitations. First, caution must be exercised in the use of SEM applications to test substantive theories in non-experimental designs. Uncontrolled (omitted) and confounding variables are a common source of misspecification that can produce misleading results. Our proposed model focused primarily on the mediating effects of distributed leadership, academic capacity and socio- curricular organization on growth rates in math achievement. However,

student growth is of course determined by other school and classroom variables as well (Creemers, 1994; Darling Hammond, 2006). There may be other mediators at work, and these may also be correlated with leadership and capacity building.

Such variables could include grouping strategies used in assigning students to classrooms (Burns & Mason, 1998) or teacher effectiveness (McCaffrey et al., 2004). In this state data base, individual teacher classroom effectiveness and collective school teaching effectiveness account for substantial variance in student math outcomes (Heck, 2009), but we were unable to link this particular student cohort to their specific teachers over time. Further research may add classrooms data as a third level to the analysis.

Moreover, although the longitudinal analyses revealed evidence of change in model constructs over time, they do not provide complete protection against a selection-bias argument. For example, teachers may perceive improvement capacity or distributed leadership more positively in schools that achieve at high levels over longer periods of time than the four years of this study. Even though we controlled for initial achievement level in our model, the achievement contexts of schools (and their unknown effects on variables) represents a possible confounding variable. In longitudinal panel studies, attrition (e.g., staff mobility) also represents a possible confounding variable (Robinson & Marsland, 2008). Although teacher turnover rates were relatively modest each year (about 8%), it remains unknown how this might affect school-wide measures of change.

Second, questions remain about the definition and measurement of distributed leadership and academic capacity as collective properties of schools. Measurement error can contribute to model misspecification which can produce misleading results (Bentler & Bonett, 1980). We took preliminary steps to assess possible changes in psychometric

properties associated with measuring the constructs on multiple occasions (Collins, Cliff, & Dent, 1988). We found the measurement properties of our constructs to be reliable. Despite this, annual school-level questionnaires are admittedly imperfect means of extracting information about organizational processes. For example, an individual's reported involvement in school decision making may, or may not, adequately capture a key aspect of distributed leadership; and even if it does, the way the individual's reply is coded into a score may bias its exact meaning (Bentler & Bonett, 1980).

Although we found that changes in levels of distributed leadership were related to changes in academic capacity and indirectly to student growth, questions remain concerning the nature of day-to-day implementation of leadership efforts aimed at improving academic capacity. Academic capacity is only a proxy for more thorough information that could be assembled about teachers' instructional behavior in classrooms (Creemers, 1994; Cohen & Hill, 2000). School-level aggregates ignore wide variations in teaching and learning conditions that may be important at the classroom level (McCaffrey et al., 2003).

Finally, questions also remain about the temporal sequence underlying associations between distributed leadership, academic capacity, and growth in student learning. Constructing a proper temporal sequence remains a consistent limitation of previous studies looking at the relationship between school leadership and school processes. Although the four-year period of this study provides additional leverage over the limitations over cross-sectional studies, it might require an even longer time frame in order to observe patterns of change in some organizational processes. Thus, we note that it remains a challenge to disentangle temporal effects in organizational studies, since one must always "jump" into a temporal sequence at some arbitrary point in time. Although

the study begins to address the issue of temporal relationships, further research is needed to refine proposed causal relationships and to eliminate possible rival explanations.

Implications

Despite these limitations, our results have several implications for research, policy, and practice. First, the research demonstrates the utility of longitudinal panel studies for modeling simultaneous change among several sets of organizational variables. We believe that this represents a useful foundation for future research on leadership effects, since school improvement, by definition, involves change over time.

Second, publication of several influential reviews of research in the 1980s (Bossert et al., 1982; Bridges, 1982; Leithwood & Montgomery, 1982; Pitner, 1988), gave impetus to the more systematic empirical study of school leadership and its effects (Hallinger & Heck, 1996). While progress has been made at identifying and specifying the nature of principal leadership effects (Bell et al., 2003; Hallinger & Heck, 1996, 1998; Leithwood et al., 2004, in press; Robinson et al., 2008; Witziers et al., 2003), it is also true that the *powerful effects* attributed to school leadership by policymakers have yet to be fully validated through empirical research (Heck & Hallinger, 2005).

Our study suggests that a historically narrow focus on the impact of *principal leadership* may have hid a portion of the school's leadership resources from our conceptual and empirical lenses. We would note that the indirect effects of distributed leadership on student learning found in this study were larger than found in many of the cross sectional studies (e.g., Heck et al., 1990, Hallinger et al., 1996; Wiley, 2001). Whether the difference in magnitude of indirect effect was due to differences in our conceptualization of leadership as an organizational property rather than of the principal,

or due to differences in the research design (i.e., cross-section vs. longitudinal), is an issue on which we cannot speculate at this time.

Over the past decade, emergent recognition of the boundaries of what principals can accomplish in the practical world of schools has led scholars to evince greater interest in conceptualizations of distributed school leadership (Gronn, 2002; Spillane, 2006). Our findings with respect to the modeling of distributed leadership support the ongoing validation of this construct and offer insight into its relationship to other key improvement factors. Future research on school leadership effects will likely benefit by incorporating an explicit measure of leadership from principals as well as a broader measure of shared leadership from other sources.

Third, with respect to policy, our research focuses attention on a set of key organizational processes (i.e., distributed leadership, academic capacity) that may be linked to successful school improvement. Distributed leadership appeared to contribute to the development of academic capacity and indirectly to student learning outcomes. Thus, the findings provide empirical support for calls for the development of broader and deeper capacity to lead in schools (Barth, 1990, 2001; Fullan, 2001; Lambert, 2002).

Our results add to the incremental process of knowledge building in the domain of school leadership effects. Validation of these findings will require researchers to follow schools for longer periods of time and conduct analyses that link changes in leadership and school organization with changes in teacher practices and student learning. Nevertheless, we conclude that these empirical results strongly support the continuation of this line of longitudinal inquiry into school leadership effects which, heretofore, has only been supported in conceptual analyses (e.g., Pitner, 1988; Hallinger & Heck, 1996).

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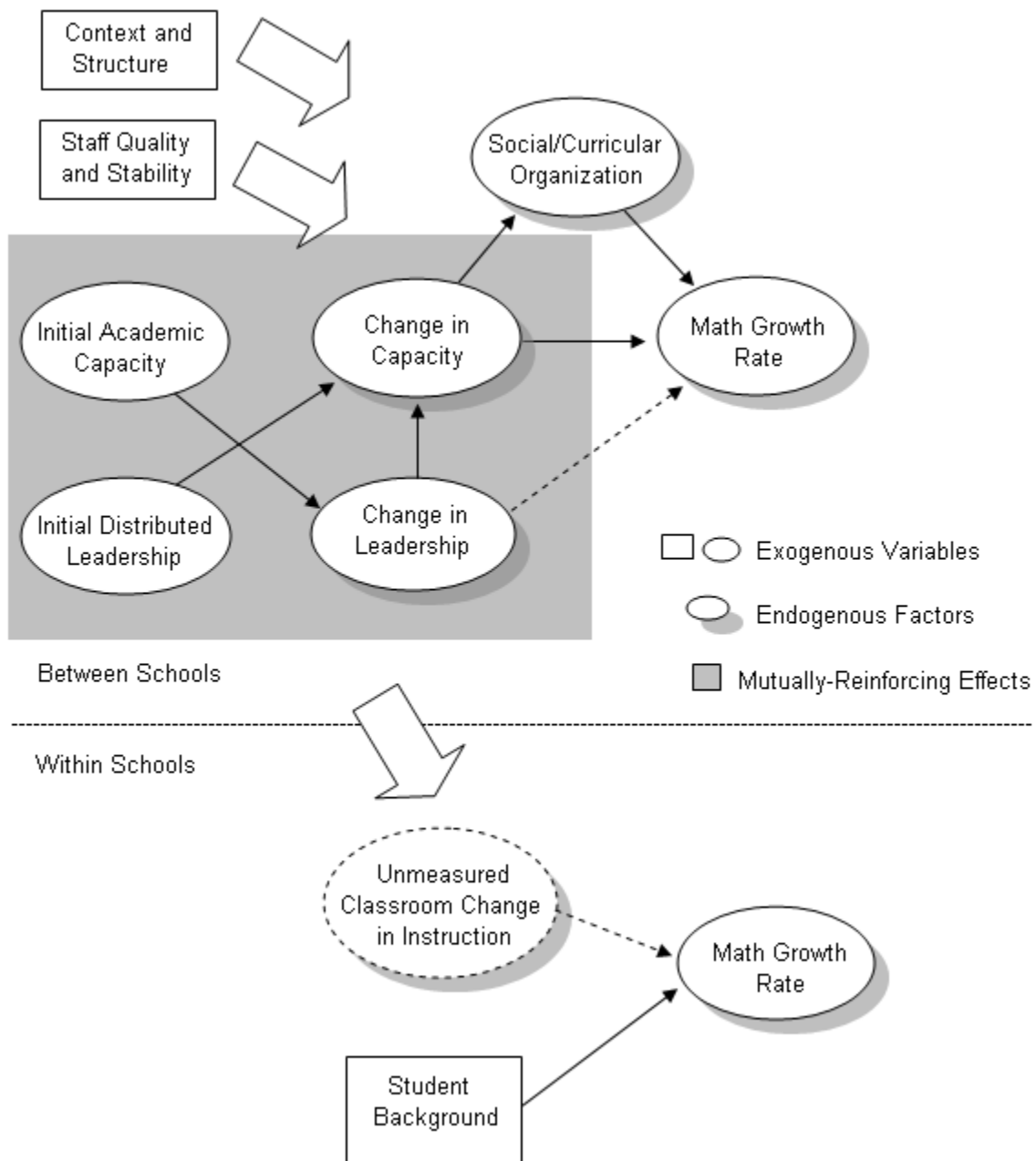


Figure 1: Conceptual Model of School Improvement Leadership and Student Learning