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An Exploratory Analysis of Formal School Leaders' Positioning in Instructional Advice and Information Networks in Elementary Schools

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This article examines how formal school leaders are positioned in their school's instructional networks based on an analysis of data from all 30 elementary schools in one mid-sized urban school district. Premised on the assumption that advice and information are key building blocks for knowledge development, we analyzed the instructional advice and information networks for mathematics and language arts, the two core elementary school subjects. Our exploratory account examines the prominence of formal leaders in their school's instructional networks as well as their membership and distribution across subgroups within these networks. Our analysis suggests that, although the school principal is not a central actor in the instructional advice and information network in a majority of these schools, formally designated school leaders as a group do occupy central positions. Examining formal school leaders' network and subgroup membership as well as their distribution across subgroups in schools, our account suggests that full-time and especially part-time formal school leaders play important roles in how elementary schools organize for instruction, brokering relations among staff and as representatives of the formal organization in subgroups. We also explore relations between formal school leaders' positioning in these networks and their schools' alignment with standards and normative structures.

For several decades, dominant empirically and theoretically grounded images of the public schoolhouse organization suggested that classroom teaching was decoupled or loosely coupled from the school's formal structure and its institutional environment (Firestone 1985; Fuller 2008; Gamoran and Dreeben 1986; Malen et al. 1990; Meyer and Rowan 1978; Weick 1976). Despite the

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pressure on school principals to be instructional leaders, a “managerial imperative” dominated their work, constraining their time on instructional matters (Cuban 1988). Still, over the past few decades, the institutional environment of America’s schools has changed considerably, especially for the core school subjects of mathematics and language arts. As policy makers throughout the education sector have legislated what teachers should teach and acceptable levels of student achievement, standards and test-based accountability have become commonplace for most public schools (Fuhrman et al. 2007; Malen 2003).

Scholars predicted that as the institutional environment of schools “become[s] more unitary and as rules about work in the technical core become more specific” and “get attached to outcomes or other inspection systems,” they would penetrate schools and affect how school staff worked (Rowan and Miskel 1999, 373; see also DiMaggio and Powell 1983; Rowan 2002). For better and worse, school leaders appear to be responding to shifts in their institutional environment (Cullen and Reback 2006; Diamond and Spillane 2004; Figlio and Winicki 2005; Hamilton et al. 2008; Ladd and Zelli 2002; Mintrop and Sunderman 2009). Rather than buffering their staff from the institutional environment, school leaders are actively working to get teachers to attend to instructional policy (Spillane et al. 2011). The emergence of an institutional environment where instructional matters figure prominently, if narrowly, has contributed to stronger environmental pressures on school leaders’ and teachers’ work with the school’s core technical work: instruction.

In light of these shifts, it seems wise to revisit the question of the role of school leaders vis-à-vis classroom instruction. Although much work continues to focus exclusively on the school principal, for good reason, scholarship on school administration increasingly argues for attention to other sources of leadership and management for instruction. Work on teacher leadership, for example, points to teachers as potentially important sources of leadership for instruction in schools. Scholars argue that, when teachers are involved in decision making, they feel a greater sense of ownership, which leads to strengthened commitment to organizational goals (Hart 1995; Stoelinga 2008; Stoe-

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linga and Mangin 2010; Weiss et al. 1992; York-Barr and Duke 2004). Moreover, teacher leaders can increase other teachers' access to expertise and support, thereby creating a more collaborative work environment (Lieberman et al. 1988; Weiss et al. 1992). Indeed, recent research indicates that the presence of an instructional coach increases teachers' ties at their school, which, in some cases, facilitates teachers' access to information about new curricula (Coburn and Russell 2008). Similarly, coaching can lead to greater reform implementation (Matsumura et al. 2010; Walpole et al. 2010; Wei et al. 2009) since teachers are more likely to make significant changes to their instruction when messages about the reform come from a coach (Coburn and Woulfin 2012).

More broadly, research that takes a distributed perspective on school leadership and management also suggests that in order to understand leadership and management arrangements for instruction it is necessary to move beyond an exclusive focus on the school principal (Camburn et al. 2003; Harris 2005; MacBeath et al. 2004; Spillane et al. 2007; Spillane et al. 2009; Timperley 2005). Other formally designated leaders in addition to the school principal take responsibility for leading and managing schools (Camburn et al. 2003; Harris 2005; Leithwood et al. 2007; MacBeath et al. 2004; Spillane and Diamond 2007).

In this article, we examine how elementary school leaders are positioned and arranged in the instructional advice and information networks for mathematics and language arts. Specifically, using social network data from all 30 elementary schools in one school district, we examine the advice and information-seeking patterns of school staff, paying particular attention to the relations between these interaction patterns and the school's formal structure (i.e., formally designated positions) and normative structure (i.e., collective responsibility and trust). We focus on advice- and information-seeking patterns because advice and information are fundamental building blocks for developing knowledge, a critical ingredient for improving instruction in schools (Darling-Hammond et al. 2009; Elmore et al. 1996; Hill 2004; NCTAF 1996). Our theory-building study investigates the following research question: How are formal school leaders positioned in the instructional advice and information networks of their schools?

Our article is organized as follows. We begin by anchoring our work in the literature. Next, we describe our research approach, including our data and data analysis. We then report on our findings. Focusing in on those individuals occupying formal leadership positions, we consider their positioning in the advice and information network for mathematics and language arts. Next, we explore formal leaders' membership in and distribution across subgroups in these networks. We then explore relations between formal school leaders'

network positioning and their school's normative structure and alignment with state and district standards.

Anchoring the Work: Formal Organization and Organizing for Instruction

Schools, like all organizations, have a formal organizational structure, a sort of blueprint for how organizational work is supposed to be done as represented in formal accounts and documents. One key aspect of formal structure is formally designated positions—that is, classroom teacher, school principal, and mentor teacher—that structure organizational members' work. For the purpose of this article, we concentrate on formal positions, paying particular attention to those individuals who occupy a formal leadership position in their school.

We can also conceptualize the school organization in terms of an informal or lived organization, emphasizing how work actually gets done in schools (Blau and Scott 1962; Weick 1979). While the formal and informal aspects of the organization are related, they are not mirror images of one another; the informal or lived organization does not always imitate the formal organization (Dalton 1959; Downs 1967; Homans 1950; Meyer and Rowan 1977). Formally designated leaders, for example, do not necessarily behave as their job descriptions suggest they should, though this is not simply a function of intentional subversion or shirking of formal responsibilities. Some organizational theorists argue that small units such as double interacts, dyads, and triads are “sensible as places to understand the major workings of organizations” (Weick 1979, 326). Framing the school organization in terms of organizing, we have to pay attention to not only the formal organizational structure but also the organization as “a group of groups” (Weick 1979, 19; see also Simon 1957). Efforts to study how schools organize for instruction, and in particular the role of formal school leaders in this organizing, must pay attention to formal and informal aspects of the school organization and relations between them (Bidwell and Yasumoto 1999; McLaughlin and Talbert 1993).

One way to think about the informal interactions is in terms of the relational structure, that is, the social relations themselves, focusing on the interactions, interconnections, and interdependencies among people (Lopez and Scott 2000). Social network analysis allows us to examine interactions among school leaders and teachers at different levels, that is, dyadic, subgroup, and organizational levels, while simultaneously attending to the formal organization in terms of formal position. An individual's access to advice and information may be mediated by colleagues in the individual's immediate circle or sub-

group. Both theoretical and empirical work suggests that subgroups are important to the flow of information. Within and between subgroup dynamics are important considerations with respect to the creation of knowledge and innovation (Granovetter 1973; Hansen 1999; Reagans and McEvily 2003; Uzzi 1997). Further, research suggests that between-subgroup ties are important in the implementation of reform in schools (Frank et al. 2004).

We can also think about organizations as having a normative structure composed of rules and expectations shared by organizational members that guide day-to-day behavior. Norms define organizational members' expectations of one another, and in this way they influence how work gets done in schools. Research on schools suggests that norms including a sense of collective responsibility for the school as a whole and trust are associated with improvement in valued school outcomes such as student achievement (Bryk and Schneider 1996; Louis et al. 1995; McLaughlin and Talbert 2001; Talbert and McLaughlin 1994).

Research Approach

To explore how formally designated school leaders are positioned in their school's instructional advice and information networks, we use data from all 30 elementary schools in one mid-sized urban school district in the southeastern United States that we refer to as Cloverville.¹ Using a comparative approach, we examine similarities and differences in how formal school leaders are positioned in the instructional advice and information networks across the 30 schools. We make no attempt to generalize beyond the schools in our study. Our descriptive theory-building study relies on survey data gathered in the spring of 2005 and again in the spring of 2007 from all elementary schools in Cloverville. We rely chiefly on the 2007 data to explore how school leaders are positioned in their school's instructional networks. Survey questions focused on various aspects of the school as an organization, including the formal organizational structure (e.g., formally designated leadership positions), normative structure (e.g., collective responsibility, teacher-teacher trust), and advice- and information-seeking behaviors for mathematics and language arts.

Data

In the 2006–7 school year, the Cloverville district served 16,214 students in its elementary schools. In the spring of 2005 and again in spring 2007, staff at each of 30 Cloverville elementary schools completed a survey. Of the 1,356 elementary school staff in the sample in 2005, 1,210 completed the survey,

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TABLE 1

Student and School Staff Characteristics in 30 Elementary Schools in 2006–7

	Minimum	Maximum	Mean	SD
Student:				
Student enrollment	354	870	540	132
African American students (%)	0	90	58	29
White students (%)	0	70	24	24
ELL students (%)	0	10	1	3
Free/reduced lunch (%)	10	90	59	24
School staff:				
Full-time staff (%)	89	100	96	3
Female staff (%)	80	98	93	5
White staff (%)	32	93	71	17
Experience (years)	9	19	13	3

NOTE.—ELL = English language learner. Only one school did not meet AYP.

for an 89% response rate, which ranged from 66% to 100%, depending on the school. Of the 1,436 elementary school staff in the sample in 2007, 1,194 completed the survey for an 83% response rate, with a range from 63% to 100% by school. Of the 1,210 elementary school staff members who completed the survey in 2005, 857 completed it again in 2007. Three schools had more than 10% English language learner (ELL) students, while most schools had full-time teachers with an average of 10 years of teaching experience, as shown in table 1.

Measures

Consistent with our conceptual framing, our measures focus on the formal organizational structure, informal interactions or relational structure, and the normative structure.

Formal organizational structure.—Our measures of formal organizational structure in schools focus chiefly on formally designated positions. We acknowledge that there are other dimensions of formal organization that are beyond the scope of this study. The positions considered are (1) *full-time formally designated leader*, such as a full-time assistant principal with main responsibility for administration rather than teaching; (2) *part-time formally designated leader*, with one or more part-time formal leadership positions, such as a part-time mentor teacher with regular teaching responsibilities; and (3) *teacher*, without a formal leadership designation, who has regular teaching responsibilities.

Relational structure or informal organization.—To measure the relational structure or informal organization, we focused on advice- and information-seeking be-

havior among school staff because advice and information are the building blocks for knowledge development. Data on the language arts and mathematics advice and information networks were based on responses to the following two questions: To whom do you turn in this school for advice or information about reading/language arts or English instruction? (five-point scales: yearly, semiannually, monthly, weekly, and daily). To whom do you turn in this school for advice or information about mathematics instruction? (five-point scales: yearly, semiannually, monthly, weekly, and daily). Using these data we calculate several measures:

Degree centrality is a measure of the prominence of an actor in a network based on the assumption that those actors who are better connected than others are more central and more prominent in the network. Degree centrality is simply a count of an actor's total number of relations. In order to control for the size of the network, we divided degree centrality by the maximum value of degree (total number of staff minus one) in each school. Further, we can break degree centrality into *in-degree centrality* and *out-degree centrality*. An actor's in-degree centrality refers to the number of people who sought out that actor for advice and information, whereas an actor's out-degree centrality refers to the number of people that actor sought out for advice.

Betweenness measures the extent to which an actor links any other two actors in the network; interactions between any two actors in a network may depend on a third actor who links them together, making the actor doing the linking more prominent in the network. Because betweenness measures the likelihood that a path from any two actors takes a specific path, we assume that the shortest path will be taken with equal weight of all lines. For example, if Jim, Kim, and Ann are all connected, then Ann has two paths to talk to Kim, one is directly and the second is through Jim. However, it is a lot simpler if Ann goes straight to Kim. We measure the betweenness of actor i by calculating the total number of geodesics (paths) between all other actors that include i . We remove all of those that connect any two actors j and k that are longer than the shortest path, and we then count all of those that include i . We divided this by the number of paths using i , so we have the following equation:

$$C_B(n_i) = \frac{\sum_{j < k} g_{jk}(n_i)}{g_{jk}}. \tag{1}$$

This explains the extent to which an actor stands between other actors. In order to control for the size of the network, we divided (eq. 1) by the total number of possible pairs:

$$C'_B(n_i) = \frac{C_B(n_i)}{(g - 1)(g - 2)/2}. \tag{2}$$

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Closeness measures the extent to which a particular actor is close to the other actors in the network. Thus, a person who is poorly connected by degree centrality but whose ties are to people who are particularly well connected will be identified as closer in the network than indicated by just their number of direct ties. This allows us to pick up on how well integrated people are into the network based on their relations with well-connected actors. We measure closeness based on the following equation:

$$C_c(n_i) = \frac{(g - 1)}{[\sum_{j=1}^g d(n_i, n_j)]}. \quad (3)$$

One technical problem with this score is that it is undefined when there is not a path that can connect any actor i with every other actor j . To circumvent this, isolated actors (i.e., not connected to anyone) are given a closeness score of 0, while the closeness score for all other actors is only calculated within each component.

Normative Structure

To measure the normative organizational structure, we relied on measures of collective responsibility, teacher-teacher trust, and alignment between standards and school programs (see app. A, available online). *Collective responsibility* measures the extent to which school staff members take responsibility for helping one another, student behavior, and improving instruction in their school as a whole; staff members were asked to indicate their level of agreement with three statements on a scale from 1 to 5. *Teacher-teacher trust* assesses the extent to which school staff members trust one another; respondents were asked to indicate their level of agreement with four statements about teachers at their school on a scale from 1 to 4. *Alignment between standards and school programs* assesses the extent to which staff members in their school align between standards and school programs; staff members were asked to indicate their level of agreement with six statements on a scale from 1 to 4.

Data Analysis

To explore the positioning of formal leaders in their school's instructional advice and information network, first of all, we calculated three measures of centrality (i.e., degree centrality, betweenness, and closeness) for language arts and mathematics networks in each school in 2007 using STATA software version 10. Second, we analyzed formal positions, including full-time and

part-time positions and multiple positions, in each school in 2007 and calculated the formal leaders to staff ratio for each school. Third, we calculated the overall proportion (%) of staff that were connected and isolated for each school as well as by positions: full-time (F), part-time (P), and teachers (T). Fourth, we compared that proportion (%) of staff who were connected and isolated as well as degree centrality, betweenness, and closeness by positions. Finally, we conducted correlation analysis among network measures (e.g., density) and school conditions (e.g., school size).

To identify formal school leaders' membership in and distribution across subgroups, we identified nonoverlapping subgroups of language arts and mathematics networks in 2005 and 2007 using the network clustering algorithm software *KliqueFinder* (Frank 1995, 1996; see app. B, available online). In addition, we calculated the proportion (%) of language arts and mathematics subgroup members and floaters (who could not be assigned to any subgroup) in each school. Finally, we compared proportion (%) of formal leaders' subgroup connection and floaters across schools.

To examine whether or not formal leaders' distribution across subgroups is related to the school's current (2007) normative structure, we used two-level multilevel models with subgroups nested in schools (see app. C, available online, for descriptive statistics, and app. D, available online, for two-level hierarchical linear models [HLM]). In the HLM models, we used the subgroup mean of measures of collective responsibility, teacher-teacher trust, and alignment between standards and school programs as our dependent variables. In addition, we used one dummy variable at subgroup level ("formal leaders belonged to a subgroup") and two dummy variables at school level ("part-time formal leaders without full-time formal leaders belonged to every subgroup" and "part-time and/or full-time formal leaders belonged to every subgroup") after controlling for prior normative structure at both subgroup and school levels.

To investigate whether or not formal leaders' distribution across subgroups is related to change in schools' normative structure, we used multiple regressions with the same two dummy variables at the school level (see app. C, available online, for descriptive statistics). Here we used the school mean of the measures of collective responsibility, teacher-teacher trust, and alignment between standards and school programs as our dependent variables because we examined change in normative structure only at the school level. In these multiple regressions we were interested in exploring school-level variability in change in the normative structure without considering subgroup-level variability because subgroup membership changed considerably from 2005 to 2007.

Findings

To answer our central research question on the positioning of formal school leaders in their schools' instructional advice and information networks, we organize our findings as follows. First, moving beyond an exclusive focus on the school principal, we identify the formally designated school leaders in the schools in our study, distinguishing between full-time formal leaders and part-time formal leaders. Second, we explore the positioning of the school principal and other formal school leaders in their schools' instructional advice and information networks. To do so, we begin by considering whether formal leaders occupy central positions in their schools' instructional advice and information networks. Turning our attention to subgroups within these instructional advice and information networks, we consider formal leaders' membership in and distribution across subgroups. Third, we explore whether formal leaders' positioning in their school's instructional advice and information networks was associated with their school's alignment with external standards and normative structure.

The School Principal Plus Other Formally Designated School Leaders

Research suggests that principals can influence the conditions that support the quantity and quality of interactions among their teachers and, in doing so, the development of trust (Darling-Hammond and Youngs 2002; Fuller 2008; Louis et al. 1996; Small 2009). By establishing both structural conditions, such as common planning time and focused professional development opportunities (Darling-Hammond and Youngs 2002; Louis et al. 1996; Louis and Marks 1998; Penuel et al. 2009), and shaping the norms and expectations for interaction within the organization (Bryk et al. 1999), principals play an important role in the development of social networks, and therefore trust, in their schools. Earlier work using a social network approach found a positive association between school principals' centrality in their schools' social network and school performance (Friedkin and Slater 1994).

Overall, the school principals in our study did not figure prominently in the language arts and mathematics networks at their schools; staff in some schools sought out their principal for advice and information, whereas in other schools they did not. Twelve principals belonged to their school's language arts networks, whereas nine belonged to their school's mathematics networks. With respect to language arts, the number of staff seeking advice from the principal ranged from zero to three, whereas for mathematics those seeking advice from the principal ranged from zero to five, depending on the school. Still, in schools where principals were more central in their school's networks,

there was more advice and information-seeking activity among staff. Specifically, there was positive association between the number of staff seeking advice or information from the principal (i.e., principal in-degree centrality) and the overall network activity or density in language arts ($r = .77, p < .001$) and mathematics ($r = .82, p < .001$). We underscore here that we make no causal claims with respect to this relationship; indeed, it could go in either direction. So while principals in almost two-thirds of the schools in our study did not occupy central positions in their school's instructional networks, when principals were central, their school's instructional networks were also denser and school staff reported that classroom instruction was more public.

While much of the empirical literature focuses exclusively on the school principal, we cast a wider net, attending to other formal leaders such as assistant principals, curriculum coordinators, and mentor teachers. On average, schools had 13 formal school leaders, ranging from six to 19, depending in part on the size of the school (Spillane et al. 2010; Spillane and Healey 2010). Nearly a third of respondents (31%) reported having a formal leadership position. Of these formal school leaders, 26% reported being full-time leaders and not being the primary instructor for any class. On average, schools had 3.3 full-time formal leaders, ranging from one to eight, depending on the school. Of the full-time leaders, most were principals ($n = 30, 31\%$), assistant principals ($n = 19, 19\%$), and whole school reform program coaches ($n = 7, 7\%$). Further, 41% of these full-time leaders reported holding two or more formal positions, such as assistant principal and whole school reform coach. Over three-quarters of those who reported having a leadership position were part-time leaders in that they were also the primary instructor for a class, including mentor teachers (54%) and coaches (18%). Of these part-time formal leaders, 66% reported holding two or more leadership positions and had significantly higher degree centrality scores (.0425) and betweenness scores (.0230) in their school's mathematics networks (but not language arts networks) than those staff who had a single leadership position (.0298, $p < .01$; .0126, $p < .01$), suggesting that holding multiple leadership positions may contribute to an individual's network centrality and integration. The number of formal leaders who had positions specific to language arts ranged from zero to seven, whereas those with mathematics specific positions ranged from zero to five, depending on the school.

There was substantial between-school variation in the formal leader to staff ratio, ranging from 1:8 to 1:1. The full-time formal leader to staff ratio ranged from roughly 1:35 to 1:4, with the mode being one full-time formal leader for every 12 staff.² As one might expect, larger schools had lower full-time leader to staff ratio than smaller schools ($r = .39, p < .05$). The ratio of language arts coordinators to other staff ranged from 0:33 to 1:5, while the ratio for mathematics coordinators to other staff ranged from 0:38 to 1:8.

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Full-time leaders in language arts were relatively rare (11 total), and full-time mathematics coordinators were rarer still, totaling five across the 30 schools. There were nine schools with one or more full-time language arts coordinators and four schools with one or more full-time mathematics coordinators.

To summarize tentatively, our analysis based on 30 schools in one district suggests that arrangements for leading and managing instruction in schools involves an array of full-time and part-time formal leaders. While schools had on average 3.3 full-time formal leaders, over 75% of those who reported having a school leadership position were part-time leaders. We also found between-school variation in these arrangements, with the formal leader to staff ratio ranging from 1:8 to 1:1, depending on the school. Overall, this analysis suggests that an exclusive focus on the school principal may under-represent the role of formal school leaders in advice and information networks in elementary schools. Consideration of other formal leaders, some full-time but mostly part-time formal leaders, suggests that the formal arrangements for leading and managing instruction are more extensive than suggested by an exclusive focus on the principal.

Considering these resources for leading and managing instruction, we thought it important to better understand the role of formal school leaders in their school's advice and information networks. Specifically, we pose the following research question: How are formally designated school leaders positioned in their school's instructional advice and information networks? We begin by considering the centrality of formal school leaders in the instructional advice and information networks of their schools, and then we turn our attention to their distribution across subgroups of staff within schools.

Formal School Leaders Centrality in Their School's Instructional Networks

Under pressure from local, state, and federal policy makers to improve student achievement and reduce the achievement gap for particular groups of students, formal leaders may no longer have the luxury of buffering teachers from external policy mandates that target classroom instruction, especially in core school subjects. As efforts to centralize guidance for instruction have become increasingly centralized over the past couple of decades, especially in core school subjects such as language arts and mathematics, we might expect that formal school leaders would play a prominent role in giving advice about instruction to school staff. Thus, we hypothesized that formal leaders would occupy central positions in the mathematics and language arts networks.

To begin with, part-time leaders were more likely to belong to their school's instructional advice and information networks than full-time leaders. While roughly three-quarters of all part-time leaders belonged to the mathematics

and language arts networks in their schools, only roughly half of the full-time leaders did. Nearly half (49%) of the full-time formally designated leaders were isolates in the language arts networks, compared with only one-quarter (26%) of part-time formally designated leaders. The situation was similar for mathematics, with over half (57%) of the full-time formally designated leaders being isolates, compared with just over one-quarter (27%) of the part-time formally designated leaders. Whether a leader was full-time or part-time was associated with being an isolate in both the language arts ($\chi^2 = 9.8, p < .01$) and mathematics ($\chi^2 = 28.3, p < .001$) networks.

There are several possible explanations that might account for this pattern. First, full-time leaders such as school principals and assistant principals are likely to have more diverse responsibilities than part-time leaders, who tend to occupy more focused leadership positions that center more on classroom instruction. While school principals' and assistant principals' responsibilities span everything from dealing with external constituents to managing the school organization to instruction, mentor teachers and teacher consultants tend to be focused on instruction (Camburn et al. 2003). Thus, full-time leaders may have less time to engage with their school's instructional advice and information networks as compared with part-time leaders. Second, part-time formal leaders continue in their role as classroom teachers, a situation that has several affordances with respect to membership in the instructional networks. As teachers, part-time leaders are more likely to be viewed by other teachers as more credible sources of instructional advice and information than full-time leaders who are no longer teachers. Further, teachers may find it easier to identify with, and open up to, part-time leaders than full-time leaders due to part-time leaders' continuing role as teachers. Finally, part-time leaders' teaching assignments may afford them more opportunities due to scheduling and more reasons due to teaching responsibilities to interact with colleagues about instruction.

Overall, formal school leaders, both part-time and full-time, did figure centrally, at least more centrally than teachers with no formal leadership designations, in their school's instructional advice and information networks. Formal leaders occupied more prominent positions in their school's instructional networks in that they had relations with more colleagues than classroom teachers (see table 2). Specifically, formal leaders had significantly higher degree centrality scores in both language arts (.042) and mathematics (.038) networks, compared with teachers (.028, $p < .001$; .025, $p < .001$, respectively).

There was considerable between-school variation, however, in the centrality of formal leaders in their school's networks. We found that, while the degree centrality of formal leaders averaged .042 in language arts and .038 in mathematics, it ranged from .02 to .09 in language arts and from .02 to .07 in mathematics, depending on the school. With the exception of the mathematics

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TABLE 2

Means and Standard Deviations of Centrality (Degree, Betweenness, and Closeness) by Position, 2007

	Degree	Betweenness	Closeness	<i>N</i>
Language arts:				
F	.045 (.083)	.028 (.060)	.028 (.012)	97
P	.040 (.046)	.018 (.041)	.031 (.013)	276
F + P	.042 (.058)	.020 (.047)	.030 (.013)	373
T	.028 (.028)	.011 (.029)	.029 (.013)	845
Total	.032 (.040)	.014 (.036)	.029 (.013)	1,218
Mathematics:				
F	.019 (.031)	.011 (.028)	.026 (.010)	97
P	.045 (.050)	.024 (.046)	.031 (.013)	276
F + P	.038 (.047)	.021 (.042)	.030 (.013)	373
T	.025 (.028)	.009 (.022)	.029 (.014)	845
Total	.029 (.035)	.013 (.030)	.029 (.014)	1,218

NOTE.—Position: F = full-time formal leaders; P = part-time formal leaders; T = teachers. Standard deviations are in parentheses.

networks, where full-time leaders were not as central as classroom teachers (.019, .025, $p = .051$), formal leaders, regardless of full-time or part-time status, occupied more prominent positions in instructional advice and information networks. Indeed, with the exception of the language arts networks in four schools and the mathematics networks in three schools, formal leaders occupied more central positions than teachers. Finally, part-time leaders were more prominent in the mathematics networks, compared with full-time leaders, with part-time leaders having significantly higher degree centrality scores than full-time leaders (.045, .019, $p < .001$). Part-time leaders had a similar degree of centrality in language arts as full-time leaders (.040, .045, $p = .60$). One possible explanation for these subject-related differences is that there were twice as many full-time language arts coordinators (11) as full-time mathematics coordinators (five).

Leaders' prominence in their schools' advice and information networks may not be just a function of the number of other staff with whom they have

relations but may also depend on the extent to which they link or connect other staff with one another. A school leader, for example, might play an important role in connecting a novice teacher experiencing difficulty teaching mathematics with a more experienced colleague known for her exemplary mathematics teaching. In this scenario, the school leader's prominence in the network is not simply a function of the advice and information provided directly but rather of the connection the leader forges between two other staff members. In schools and other organizations, interactions among any two organizational members often depend on a third actor who brokers relations among them. We examined the extent to which formal leaders brokered relations between staff by calculating actors' betweenness, that is, a measure of centrality that takes into account the extent to which the actor links other actors.

Compared with teachers with no formal leadership designations, formal school leaders were more likely to broker relations among school staff in both language arts and mathematics (see table 2). Formal leaders had significantly higher betweenness scores compared with teachers in both language arts (.020, .011, $p < .001$) and mathematics (.021, .009, $p < .001$). While part-time leaders had significantly higher betweenness scores in mathematics than full-time leaders (.024, .011, $p < .001$), their betweenness scores in language arts were lower than those of full-time leaders, although the difference was not statistically significant (.018, .028, $p = .078$). There was tremendous between-school variation, with the average betweenness scores of formal leaders ranging from .00 to .07 in language arts and from .00 to .06 in mathematics. While formal leaders as a group brokered no relations among staff in some schools, in other schools they were the primary brokers. Except for seven schools in language arts and three schools in mathematics, formal leaders did more brokering than teachers. Formal leaders then were more likely to broker relations among colleagues than teachers with no formal leadership designation, and those doing the brokering in mathematics were more likely to be part-time rather than full-time leaders.

Finally, we also examined how close formal leaders were to other staff members, using closeness, a measure that includes both direct and indirect ties to others in the network. Individuals who have relatively few direct ties (degree centrality) but whose direct connections are to actors who are particularly well connected to others in the network score higher on measures of closeness than on degree centrality. Closeness may be especially important for formal school leaders; school principals may have relatively few direct ties with other staff members, but those direct ties they do have may be with well-connected actors, such as other formal leaders, thereby increasing their prominence in the network. For example, while school principals may not be connected to most teachers in their schools, they may have a connection with

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each grade-level lead teacher, who, in turn, is connected with every teacher in the grade. Closeness gives us a sense of how well formal leaders are integrated into their school's instructional networks. Part-time leaders were more integrated into their schools' instructional advice and information networks for mathematics and language arts than either classroom teachers or full-time formal leaders (see table 2). Part-time formal leaders had higher closeness scores in both language arts and mathematics, compared with teachers' closeness scores (.031, .029, $p = .06$; .0314, .0285, $p < .01$) and full-time leaders' closeness scores (.028, $p = .06$; .026, $p < .001$). Part-time leaders tend to be more integrated into the language arts and mathematics instructional networks than either full-time leaders or teachers, perhaps in part reflecting their dual roles as teachers and school leaders.

Overall, formal school leaders occupied more central roles in the advice and information networks for mathematics and language arts than regular classroom teachers with no formal leadership positions. With the exception of brokering relations in mathematics, part-time formal leaders did more brokering and had closer relationships with their colleagues, compared with full-time leaders. This suggests that part-time formal leaders play an important role in connecting school staff members to one another with respect to instruction in the two core elementary school subjects.

Formal School Leaders' Membership in and Distribution across Subgroups

Our account to date has focused on how formal school leaders are positioned in their school's mathematics and language arts networks. As discussed earlier, however, these networks are made up of subgroups, that is, groups of actors who typically have stronger ties to one another than to others in the overall network. These subgroups are critical to the functioning of the overall network and the organization (Daly 2010). At least some formal leadership positions are subunit-specific, such as grade-level team leader or department chair. Of course, subgroups can form for different reasons, not just common grade-level assignments, including tenure in the profession or time at the school.

Subgroups are important to the overall functioning of the school organization for a couple of reasons. First, individuals tend to be influenced most by those in their immediate or primary group, and strong ties among subgroup members enable joint action and the transfer of resources (e.g., information) among members (Frank 1995, 1996; Reagans and McEvily 2003). Subgroups influence how teachers experience their school organization. Teachers who have different grade-level or school-subject department assignments, for example, can experience the formal organization in very different ways (Bakkenes et al. 1999; Bryk and Schneider 2002; Daly and Finnigan 2010). Thus, the

distribution of formal school leaders across subgroups may be important in ensuring that the formal organization's position(s) on key matters are represented within each subgroup.

Second, inter-subgroup communication is also important to the functioning of the school as an organization. Subgroups organized mostly around grade levels that rarely interact with one another, for example, can impede the vertical alignment of the elementary school curriculum. There is some evidence that overlapping subgroups with organizational members belonging to multiple subgroups influences performance (Frank 1996). Further, connections between subgroups can enable the implementation of change by promoting the exchange of new information and connecting the formal school organization with the informal organization (Chrispeels et al. 2008; Frank et al. 2013; Frank and Zhao 2005; Kim 2011; Penuel et al. 2010, 2011).

Acknowledging the importance of subgroups to the overall functioning of networks and organizations, we considered formal school leaders' memberships in subgroups as well as their distribution across subgroups in schools. We identified 103 subgroups for language arts, ranging from one to six, depending on the school, with the modal category being two. We identified a total of 96 subgroups for mathematics, ranging from one in two schools to seven at another two schools, with the modal category being four subgroups. As explained in our method section, some school staff did not belong to a subgroup for one of four reasons: they were isolates, they had connections only with individuals outside their school, they had connections only with colleagues who had not responded to the survey, or they could have been assigned to two or more subgroups. We refer to those staff members who could be assigned to two or more subgroups as floaters to denote their potential for membership in multiple subgroups.

Floaters are potentially important in that by virtue of fitting into two or more groups they may play an important role in communication between subgroups. With respect to the language arts networks, 9% of school staff members were floaters, ranging from 0% to 30% by school.³ With respect to the mathematics network, 9% of staff members were floaters, ranging from 0% to 27%, depending on the school, in mathematics. Overall, subgroup membership ranged from a low of 34% at one school to a high of 81% at another in language arts and from a low of 29% to a high of 81% for mathematics (see table 3). Subgroup membership was negatively correlated with the number of floaters in both language arts ($r = -.52, p < .01$) and mathematics ($r = -.54, p < .01$), suggesting that schools low in subgroup membership are high on floaters. However, because it takes much time to separate out floaters who could be assigned to two or more groups from the other two types of floaters, investigating the issue of multiple subgroup membership is beyond the scope of the current article and is a limitation in our analysis.

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TABLE 3

Percent (Range) of School Staff in Networks and Subgroups, 2007

	NETWORK CONNECTIONS		NETWORK ISOLATION		SUBGROUP MEMBERSHIP		FLOATERS	
	Language Arts	Math	Language Arts	Math	Language Arts	Math*	Language Arts	Math*
Percent	71	66	29	35	59	56	9	9
Range	(54–84)	(46–86)	(9–59)	(10–63)	(34–81)	(29–81)	(0–30)	(0–27)

* Two schools are excluded in this calculation because KliqueFinder could not identify cohesive subgroups in these schools.

While teachers were more likely to belong to a subgroup than full-time leaders in both language arts ($\chi^2 = 7.3, p < .01$) and mathematics ($\chi^2 = 10.9, p < .01$), they were less likely than part-time leaders to belong to a mathematics subgroup ($\chi^2 = 20.2, p < .001$). In both the mathematics and language arts networks, part-time formal leaders were more likely to belong to a subgroup than full-time leaders ($\chi^2 = 31.7, p < .001$, for mathematics; $\chi^2 = 11.1, p < .01$, for language arts). Specifically, over three-fifths (62%) of the part-time formal leaders belonged to a language arts subgroup, compared with less than half (44%) of the full-time formal leaders (see table 4). These differences were even more pronounced in mathematics, where two-thirds of part-time formal leaders belonged to a subgroup, compared with only one-third of full-time leaders (see table 4). Part-time leaders may be more likely to belong to subgroups than full-time leaders because they have regular teaching assignments and thus are more likely to identify with classroom teachers and be identified by classroom teachers as teachers as distinct from formal leaders. Part-time leaders, for example, are more likely to be part of a grade-level team.

Based on the assumption that the representation of the formal school organization across subgroups might be important to the overall functioning of the school, we considered the distribution of formal leaders across subgroups within schools. With respect to the 103 language arts subgroups, 83% ($n = 86$) included either a full-time formally designated leader or part-time formally designated leaders. The situation was roughly similar for mathematics, with 83 mathematics subgroups (87%) including either a full-time formally designated leader or part-time formally designated leaders. So, in roughly one of every five subgroups the formal organization was not represented across the 30 schools. While formal leaders were represented in more than four out of five subgroups for two school subjects, this ranged from half of the subgroups in one school to all five subgroups in another school. We found no significant differences between schools where formal leaders were floaters from schools where they were not in terms of school norms or changes in school norms.

Of particular note in our analysis is that part-time formal leaders played

TABLE 4

Percent of School Staff in Networks by Position, 2007

	Subgroup	Isolates	Floater	<i>N</i>
Language Arts:**				
F	44	50	6	94
P	62	31	7	270
T	60	33	7	828
Mathematics:***				
F	33	57	10	96
P	67	27	6	266
T	52	39	9	830

NOTE.—Position: F = full-time formal leaders; P = part-time formal leaders; T = teachers. One person subgroup (27 for language arts and mathematics networks) and missing cases (5) were excluded in the χ^2 test.

** $p < .01$, χ^2 test.

*** $p < .001$, χ^2 test.

an important role in representing the formal organization across subgroups. With respect to the mathematics networks, for example, 58 subgroups (61%) included a part-time formal leader but no full-time formal leaders, whereas in the language arts networks over half of the 103 networks (54%) included part-time formal leaders with no full-time leader. Thus, over half of the subgroups in both school subjects relied on part-time leaders to represent the formal organization. Overall, this suggests that part-time leaders who have regular teaching assignments play an important role in representing the formal organization within subgroups in elementary schools. Absent these part-time formal leaders, the formal organization would not be represented in 50% or more of the subgroups in the two core elementary school subjects.

We found variation among schools in the distribution of formal leaders across subgroups. For the language arts network, in 17 schools, formally designated leaders were represented in every subgroup, whereas in 13 schools the representation of formally designated leaders ranged from 50% to 83% of the subgroups. With respect to the mathematics network, in 18 schools, formally designated leaders were represented in every subgroup, whereas in 10 schools, the representation of formally designated leaders in subgroups ranged from 50% to 86% of the subgroups.⁴

Our account suggests that, when compared with teachers, formal school leaders tend to occupy more central, integrated, and brokering positions in their school’s instructional advice and information networks, though there were differences between part-time and full-time formal leaders. For the most part, our analysis suggests that the formal organizational structure (i.e., formally designated leadership position) is positively associated with the school’s

relational structure in that individuals occupying these positions have more central, integrated, and brokering roles in interactions about instruction among school staff.

School Leaders' Network Positioning, Normative Structure, and Alignment with Standards

We also examined associations between school leaders' positioning in the language arts and mathematics networks and alignment with state and district standards and the normative structure at both the subgroup and school levels. With respect to school norms, we focused on collective responsibility and trust in particular because prior work suggests that these norms are associated with improvements in valued school outcomes such as student achievement (Bryk and Schneider 1996; Lee and Loeb 2000). To explore these associations, we used two-level multilevel models with subgroups nested in schools (see table 5). While we conducted this analysis for both the language arts and mathematics networks, we only found statistically significant relationships for mathematics. At the subgroup level, there was a significantly positive effect of the dummy variable (i.e., formal leaders belonging to the mathematics subgroup) on teacher-teacher trust (coefficient of .13) and alignment between standards and school programs (coefficient of .15), compared to the mathematics subgroup, where formal leaders did not belong, after controlling for prior subgroup norm (see table 5).⁵ Having a formal leader in a subgroup then was positively associated with subgroup members' reports of alignment of school programs with external standards and with norms of trust.

With respect to the school level, there was a significantly positive relationship between the dummy variable (i.e., schools where every mathematics subgroup included at least one part-time leader without full-time formal leaders) and collective responsibility (coefficient of .47), teacher-teacher trust (coefficient of .36), alignment between standards and school programs (coefficient of .23), compared to schools where every mathematics subgroup did not include at least one formal leaders, after controlling for prior school norm (see table 5). In addition, there was a significantly positive relationship between the dummy variable (schools where every mathematics subgroup included at least one part-time formal leader and/or full-time formal leader) and collective responsibility (coefficient of .33) and teacher-teacher trust (coefficient of .23), compared to schools where every mathematics subgroup did not include at least one formal leader, after controlling for prior school norm (see table 5).

We also used multiple regressions, because we were interested in school-level variability in change in norms (rather than subgroup level variability). We found that formal leaders' distribution across subgroups was associated

TABLE 5

Hierarchical Linear Models Results of Norms

	COLLECTIVE RESPONSIBILITY	TEACHER-TEACHER TRUST	ALIGNMENT
Coefficient and Standard Error			
Fixed effect:			
Level/variable:			
Subgroup (<i>n</i> = 93):			
Prior subgroup norm	.22 (.14)	.08 (.11)	.15 (.15)
Subgroup size	-.015* (.007)	-.01 ⁺ (.006)	-.005 (.004)
Formal leaders in subgroup	.07 (.10)	.13* (.06)	.15* (.08)
School (<i>n</i> = 28):			
Intercept	.68 (.51)	.82 ⁺ (.41)	.96 (.62)
Prior school norm	.57* (.21)	.60** (.19)	.48* (.21)
P in every subgroup	.47** (.16)	.36** (.10)	.23** (.07)
F and/or P in every subgroup	.33* (.13)	.23* (.11)	.15 ⁺ (.07)
Variance			
Random effect:			
School mean	.06***	.03***	.02**
Subgroup effect	.12	.06	.05
Reliability coefficient	.60	.62	.45

NOTE.—Position: F = full-time formal leaders; P = part-time formal leaders; T = teachers. Standard errors are in parentheses. HLM software version 6 was used for this analysis. We also tested the effect of Title 1 schools in this model, but we did not find a significant relationship. Thus, we excluded the Title 1 variable in the final models. In addition, we also analyzed other school norms, such as teacher influence, data-driven decision making, and openness to innovations. Because we obtained similar results to collective responsibility and there was high correlation between collective responsibility and other school norms ($r = .67$ for teacher influence; $r = .79$ for data-driven decision making; $r = .88$ for openness to innovations), we decided to focus on collective responsibility and teacher-teacher trust.

⁺ $p < .10$.
^{*} $p < .05$.
^{**} $p < .01$.
^{***} $p < .001$.

with the change in normative structure (see table 6). First, schools where part-time leaders were represented in every mathematics subgroup in 2007 had significantly positive change in collective responsibility, teacher-teacher trust, and alignment with state and district standards, compared to schools where formal leaders were not represented in every mathematics subgroup. Second, schools where full- and/or part-time leaders were represented in every math-

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TABLE 6

Change in Norm from 2005 to 2007 at the School Level

	COLLECTIVE RESPONSIBILITY			TEACHER- TEACHER TRUST			ALIGNMENT		
	B	SE	β	B	SE	β	B	SE	β
Intercept	-.18*	.08		-.20*	.07		-.16*	.05	
P in every subgroup	.34*	.13	.52	.30*	.11	.52	.20*	.08	.48
F and/or P in every subgroup	.26*	.11	.45	.20 ⁺	.10	.39	.15 ⁺	.07	.40
Adjusted R^2		.20			.18			.15	

NOTE.—School $n = 28$. B = unstandardized coefficient; SE = standard error; and β = standardized coefficient. Position: F = full-time formal leaders; P = part-time formal leaders. SPSS software version 19 was used for this analysis. We also tested the effect of Title 1 schools in this model, but we did not find a significant relationship. Thus, we excluded the Title 1 variable in the final models.

⁺ $p < .10$.

* $p < .05$.

ematics subgroup in 2007 had significantly positive change in collective responsibility, teacher-teacher trust, and alignment with state and district standards, compared with schools where formal leaders were not represented in every mathematics subgroup. Overall, our analysis suggests that formal leaders' membership in and distribution across subgroups within schools were associated with the normative structure as well as alignment with external standards.

Discussion and Conclusion

In this article, we explored relations between an aspect of the formal organizational structure, formally designated position, and the relational structure. We did this by examining the positioning of formal leaders in their school's instructional advice and information networks for both mathematics and language arts. Focusing not only on the school principal but formally designated leaders writ large, we show that formal leaders do play prominent roles in their school's instructional advice and information networks. Further, formal leaders were prominent in brokering relations among staff in both the mathematics and language arts networks.

Our analysis also suggests that part-time formal leaders' network positioning differs from that of full-time leaders' positioning. Compared with full-time leaders, part-time leaders in our study were more integrated into their school's advice and information networks and were more likely to broker relations

among school staff. These differences between part-time and full-time leaders may in part reflect the dual roles of part-time leaders who maintain their position as classroom teacher while taking on a formal leadership role. As teachers, they are more likely to continue to engage with other teachers as teachers about classroom instruction, enabling them to maintain their peer and collaborator status while also assuming a formal leadership position.

Maintaining these dual positions may be especially important for formal leaders. Research on full-time teacher leaders (e.g., instructional coaches) suggests that these leaders often struggle to be viewed as experts by teachers (Mangin 2005; Stoelinga and Mangin 2010). Taking on a full-time formal leadership position, a teacher is no longer viewed as a peer by other teachers, creating a situation where the teacher leader must work to gain teachers' trust and thus does not assert her position as an expert (Mangin 2005). Research on professional development schools suggests that teacher leadership functions most effectively when it is "embedded in tasks and roles that do not create artificial, imposed, formal hierarchies and positions" (Darling-Hammond et al. 1995, 89). Our analysis suggests that part-time leaders may be in a unique position to address these challenges; their dual positions both as teachers and as formal leaders enable them to continue to be viewed as peers by other teachers as they also take on leadership responsibilities. Still, the potential challenges of managing these dual and potentially dueling roles should not be ignored. Some research suggests that teacher leaders who are not released from classroom responsibilities face structural constraints of time and access that create tensions and limit the extent to which these leaders can engage with other teachers on instructional improvement (Smylie and Denny 1990). At a minimum, our analysis suggests that the work of part-time leaders, given their more central and more integrated positions in their school's instructional advice and information networks, merits more attention from researchers.

Our analysis also suggests that formal school leaders' positioning in the advice and information networks is positively associated with their school's alignment with external government standards and their school's normative structure. We can think about formal school leaders as representatives of external government policy, or perhaps negotiators between government policy and classroom teachers as they manage in the middle (Spillane and Anderson 2012). Maintaining the confidence of external stakeholders is a critical challenge for school leaders (Kraatz 2009). Thus, it is perhaps not surprising that teachers in subgroups where formal leaders are represented reported greater alignment between school programs and external government standards. At the same time, school leaders also face the related but different challenge of creating a somewhat cohesive school organization. A core aspect of this work is developing and maintaining organizational norms. Our analysis suggests that formal school leaders' membership in and distribution across subgroups

is related to norms of trust and collective responsibility as well as to alignment with external government standards.

Finally, a theme threaded throughout our analysis, but never explicitly addressed, concerns how the school subject appears to matter with respect to the positioning of formal school leaders in their schools advice and information networks. Further, while the positioning of formal school leaders in their schools' advice and information networks was associated in a statistically significant way with both the normative structure and alignment with external standards, these associations were only present in the mathematics networks, not in the language arts networks. Taken together, our analysis suggests that the school subject matters with respect to how formal school leaders are positioned in their school's advice and information networks and the relationship of this positioning to the school's normative structure and alignment with standards. In sum, future research on how elementary schools organize for instruction and the positioning of formal school leaders in this organizing should consider the school subject as a potentially important explanatory variable.

Moving beyond an exclusive focus on the school principal and taking other formally designated leaders, full-time and part-time, into account, our analysis suggests that the formal organization (as represented by formal leaders) is centrally positioned in these elementary schools' instructional advice and information networks. Our account also underscores the important role that part-time formal leaders play in this centrality, doing more brokering and having closer relationships with their colleagues as compared with full-time leaders. In addition, formal leaders' membership in mathematics subgroups was positively associated with subgroup members' reports of alignment of school programs with external standards and norms of trust. Further, our analysis also found a positive association between the distribution of formally designated leaders across mathematics subgroups within schools and norms of trust and collective responsibility as well as with positive changes in these norms from 2005 to 2007.

Overall, our exploratory analysis makes a case for more research on formally designated school leaders writ large (not just the school principal) as a collective and their positioning in instructional advice and information-seeking and providing behavior in schools. In particular, research designs are needed that can support causal inferences on relations between changes in the formal organizational structure (e.g., the creation of new formally designated school leadership positions) and the structure of social networks in schools as well as on relations between the positioning of formally designated school leaders in these networks and those organizational conditions thought critical for school improvement (e.g., collective responsibility, trust). In the meantime, if our analysis is roughly right, albeit based on only 30 schools in one urban school district,

educational policy makers and school principals should pay careful attention to who occupies formally designated leadership positions in their schools. These individuals, especially those who occupy part-time leadership positions, are important sources for instructional advice and information, that is, the sort of advice and information that is often essential for implementing new programs and instructional improvement more generally.

Notes

1. Cloverville is a pseudonym.
2. We include other formal leaders who are not full-time in their leadership position in this calculation.
3. Here we include all 30 elementary schools.
4. Every school had more formal leaders than number of subgroups in both mathematics and language arts in 2007.
5. We controlled here for the mean scores in 2005 of subgroups in 2007.

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