Intra- and Interschool Interactions about Instruction: Exploring the Conditions for Social Capital Development

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Although social ties are a necessary condition for social capital, there is a dearth of research on the factors associated with the existence of such ties among school staff. Using a mixed-methods approach, we examined the role of both formal organizational infrastructure and individual characteristics in shaping advice and information interactions about instruction among school staff within and between schools. Our findings from social-network models showed that, while individual characteristics were associated with within- and between-school ties, aspects of the formal school organization had larger effects. Moreover, having a subject-specific leadership position most strongly predicted between-school ties. Our analysis of interview data supported and extended these findings, showing that leadership positions worked in tandem with other aspects of the organizational infrastructure, such as organizational routines, to influence school staff members’ interactions about instruction.

An expanding literature points to the importance of social relations in organizations, including schools. Specifically, social relations theorized as essential for social-capital development can be a source of resources including trust, expertise, and incentives for innovation (Bryk and Schneider 2002; Coburn 2001; Daly et al. 2010; Frank et al. 2004, 2011; Louis et al. 1996; Moolenaar et al. 2014). Such resources can enable improvement in teaching and student learning. Moreover, social resources attained through relationships have been
linked to teacher productivity and student achievement (Leana and Pil 2006; Pil and Leana 2009). Research suggests a relationship between a school’s social capital and measures of school performance including reform implementation, parental satisfaction, student attendance and achievement, and teacher commitment (Penuel et al. 2009, 2010; Supovitz et al. 2010).

Yet there are gaps in empirical knowledge on social capital in schools. First, the literature has largely focused on returns from social capital, but the factors and mechanisms associated with the presence of social ties that can enable the development of social capital remain largely unexplored (Coburn 2001; Small 2009; Spillane et al. 2012). The literature on teachers’ advice and information ties has generally focused on demographics, factors internal to the school, or the implications of ties for professional learning and development (Frank 2009; Moolenaar et al. 2014; Penuel et al. 2012; Sun et al. 2013). Social ties are neither “a natural given” nor “a social given” (Bourdieu 1986, 249). Thus, it is essential to understand those factors associated with the presence (or absence) of social ties, a necessary prerequisite for facilitating access to social resources, so research can inform efforts to build social capital.

Second, most research focuses on social relations within schools among students and among staff (Coburn et al. 2012; Daly et al. 2010; Frank et al. 2004, 2011; Hallinan 2007; Leana and Pil 2006; Moolenaar et al. 2011, 2014; Pil and Leana 2009; Spillane et al. 2012). While these intraschool relations are important (Coburn 2001; Penuel et al. 2010; Pil and Leana 2009), situating these relations in local education systems is also important. Theoretical and empirical work on social capital distinguishes between relations that are internal to an organization and those relations that are external, suggesting that both are critical to organizational functioning (Adler and Kwon 2002; Burt 2000). Additionally, ties among actors within an organization are not just about the individual (i.e., teacher) or the organization (i.e., school) but also about how these actors are located within a broader system (Bidwell and Kasarda 1987; Small 2009).

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Attention to both internal and external ties is relevant for schools because these organizations are nested in local school districts. Although arrangements differ between and within states, the school district is the primary administrative unit for delivering education in the United States, collecting local taxes and having responsibility for managing most state and federal funding (Kirst and Wirt 2009; Tyack 1974). Schools share resources such as funding and teachers and rely on the same district specialists. Even under recent state and federal policy changes, school districts maintain a central role in providing technical assistance (Mitchell et al. 2011). Yet, few studies examine both intra- and interschool relations within school districts (for exceptions, see Coburn and Russell 2008; Daly and Finnigan 2012; Hite et al. 2005, 2006).

In this article, we examine intra- and interschool social relations using data from 28 elementary schools in two US school districts in one Midwestern state. We focus specifically on instructional advice and information ties within and between schools because advice and information are fundamental building blocks for developing knowledge about instruction (Bransford et al. 2000), and this knowledge is essential to improving teaching and learning (Elmore 1996; Hill 2004). We begin by motivating and situating our work with the empirical and theoretical literature on social capital. Next, we describe our methods involving social-network analysis (SNA) and analysis of qualitative interviews. Turning to findings, we first present statistical models to identify those factors associated with the existence of intra- and interschool ties. Next, based on an analysis of our qualitative interview data, we support and extend our quantitative analysis, identifying how aspects of the formal organization influence advice and information ties. We conclude by discussing our findings.

Our contributions are twofold: Our work replicates a handful of prior studies on those factors associated with the presence of ties between school staff related to instruction (Frank 2009; Moolenaar et al. 2014; Spillane et al. 2012). Such replication is essential in our field if we are to amass an empirical body of knowledge to inform policy and practice (Makel and Plucker 2014). In addition, our study extends the empirical knowledge base in several ways. First, we attend to both intra- and interschool instructional ties simultaneously, and we do so for all staff and all elementary schools in two school districts. Prior work that has attended to interschool ties has focused too narrowly on school principals as the critical nodes for these ties. Second, based on our qualitative analysis, we extend our quantitative findings and hypothesize relations between formal structure (e.g., formal position, formal routine) and school staffs’ perceived expertise using the construct of transactive memory. Third, we make two methodological contributions, the first in the form of a new statistical social-network model that incorporates covariates into a blockmodel to estimate covariates’ effects within and across schools, and the second in our illustration of
how qualitative data can be used not only to corroborate quantitative findings but also to extend them in key ways.

Motivating and Framing the Research

Social capital refers to real or potential resources for action attained through relationships (Bourdieu 1986; Coleman 1988; Lin 1982, 2001). Resources can take many forms, including goods and services, trust, information, and social obligation (Coleman 1988; Inkpen and Tsang 2005; Nahapiet and Ghoshal 1998), and individuals and organizations can invest in, and benefit from, social capital (Ibarra et al. 2005). We motivate and frame our work with research on social capital. First, we argue that advice and information acquired through social relations are important for human capital development. Second, we justify focusing on intra- and interschool advice and information interactions by identifying internal and external dimensions of social-capital development and noting the limited attention given to the factors that predict social ties.

Social Capital and Human Capital

New knowledge is one of two core ingredients (i.e., skill and will) essential for improving teaching. Some scholars argue that social capital can be important in developing human capital (i.e., individual knowledge and skill), especially in knowledge-intensive organizations like schools (Coleman 1988; Loury 1987). Schools are knowledge-intensive organizations because of the complexity of teaching, including variability in student needs, the uncertainty of teacher-student relations, and disagreement about how best to teach (Barr and Dreeben 1983; Bidwell 1965; Bidwell and Kasarda 1987; Cohen 1988; Meyer and Rowan 1977). In such organizations, the ongoing development of human capital is necessary, and developing social capital is one way to grow this human capital (Frank et al. 2011; Zhao and Frank 2003).

Social relations are a necessary if insufficient condition for social-capital development. Social relations can facilitate access to resources such as advice and information and allow people to pool information that potentially enables knowledge development (Coburn 2001; Daly and Finnigan 2010; Frank et al. 2004, 2011; Kim 2011; Spillane 2004; Uzzi 1997). When individuals encounter new information or when they combine different pieces of information, they can develop new knowledge (Choo 1998). Further, relations among people provide opportunities for making tacit knowledge explicit and therefore more readily available to others (Eraut 2000).
Within schools, social capital enables instructional reform and school improvement (Bryk and Schneider 2002; Frank et al. 2004; Louis and Kruse 1995; McLaughlin and Talbert 2001; Rosenholtz 1991; Smylie and Hart 1999). Scholars have empirically shown teachers’ on-the-job learning from interactions with peers (Eraut and Hirsh 2007; Frank et al. 2004). Teachers create learning opportunities when they share expertise, talk about new material, and discuss effective teaching (Brownell et al. 1997; Davis 2003; Little 2003; Smylie 1995). Strong ties can enhance teacher commitment and contribute to a sense of belonging and efficacy (Grodsky and Gamoran 2003).

Higher levels of teacher interaction are associated with higher student achievement in both mathematics and language arts, after controlling for school and individual factors (Goddard et al. 2007; Pil and Leana 2009). Teachers who interact do learn from one another, with teachers who have more effective peers being more effective themselves; teachers’ learning from peers accounted for 20% of the variation in their instructional effectiveness (Goldhaber and Hansen 2010; Jackson and Bruegman 2009). Thus, social capital is important for the development of teachers’ knowledge and skills (i.e., human capital), which in turn matters for student outcomes.

Internal and External Dimensions of Social Capital

Social capital in organizations has both internal and external dimensions (Leana and Pil 2006). The internal dimension refers to relations within the organization (i.e., intraorganizational relations), whereas the external dimension refers to ties that reach beyond the immediate organization (i.e., interorganizational relations).

Several factors predict social ties within organizations. At the individual level, people tend to interact with others similar to them in age, race, gender, education, and values (McPherson et al. 2001; Monge and Contractor 2003). Research offers empirical support for this homophily theory, especially with respect to race and ethnicity (Mollica et al. 2003; Shrum et al. 1988), education (e.g., Marsden 1987), gender (Ibarra 1992; Leenders 1996; Moolenaar et al. 2014), and age (Feld 1982). At the organizational level, social ties are embedded in organizations that bring people together who might not otherwise connect, and the formal organizational structure can enable or constrain these interactions (Blau 1955; Blau and Scott 1962).

A recent study examining advice and information ties within schools found that both individual and organizational factors predicted ties among school staff members (Spillane et al. 2012). Similarity of race and gender were asso-
associated with the presence of an instructional advice and information tie. Years of experience also mattered. Still, holding a formal leadership position and having the same grade-level assignment were more strongly associated with the presence of an instructional tie (see also Moolenaar et al. 2014). Other work has investigated associations between school commitment and ties (Frank 2009), professional development and ties (Penuel et al. 2012), and the importance of teacher and school demographics to tie formation (Moolenaar et al. 2014).

Although important, internal social capital can also have a downside because close ties can promote a counterproductive conformity among organizational members (Portes 1998) by stifling new ideas (Uzzi 1997), reinforcing redundancy (Burt 1992), and limiting access to novel information (Szulanski 1996). External ties are more likely to provide access to new information, reducing the likelihood of conformity and groupthink (Hansen 1999; Krackhardt and Stern 1988). Such interorganizational ties complement intraorganizational ties by providing new information, which is then combined and used internally through strong relationships (Burt 2000; Hansen 1999). Hence, it is important to examine both internal and external dimensions of an organization’s social capital (Burt 2000).

With some exceptions, education research has focused mostly on internal social capital, and few studies have examined the mechanisms that account for the presence of internal and external ties among school staff. The limited scholarship on intra- and interschool ties indicates that social relations that span “multiple knowledge pools,” or those that reach beyond a teacher’s immediate grade level or school, allow school staff to access new information (Reagans and McEvily 2003, 242). Also, teachers who were involved in multiple communities of practice both within and outside their schools were engaged in more substantive conversations about content-specific instruction (Stein and Coburn 2008). Still, between-school interactions may be limited, as one study of school principals showed that although there were few overall interactions related to best practices among school principals, principals in high-performing schools interacted more with other principals than those in low-performing schools (Daly and Finnigan 2012). This study adds to this body of work by simultaneously examining intra- and interschool relations and the factors influencing them.

Method

Our analysis is based on data from a longitudinal study in two midsized Midwestern school districts we refer to as Auburn Park and Twin Rivers.
Auburn Park is a suburban school district serving a predominantly white population (82% white, 6% Latina/o, and 5% African American or black), and Twin Rivers is a rural school district that serves a larger Latina/o student population (47% white, 45% Latina/o, 4% African American or black) and has more students receiving free or reduced-price lunches (68% compared to 25% in Auburn Park). During the 2012–13 school year, there were 5,852 students enrolled in Auburn Park’s 14 elementary schools and 4,556 students enrolled in Twin Rivers’ 14 elementary schools.

**Data Sources**

All elementary-school teaching and administrative staff members filled out a School Staff Questionnaire (SSQ) in spring 2013 that asked questions related to school culture, advice and information interactions, and respondents’ backgrounds. In Auburn Park, 384 of 410 school staff members responded to the survey, and school response rates varied from 87% to 100%, with an overall response rate of 94%. In Twin Rivers, 316 of 382 school staff responded to the survey, varying from 68% to 96% by school, with an overall response rate of 83%.

The social-network survey items, developed and validated in other studies (Pitts and Spillane 2009; Pustejovsky and Spillane 2009), asked: “During this school year, to whom have you turned for advice and/or information about curriculum, teaching, and student learning?” Survey respondents listed up to 12 individuals, and these names were autopopulated in a follow-up question that asked respondents to indicate the content area, including reading and English language arts (which we refer to as “language arts”) and mathematics, for which they sought advice and/or information from each person.

We also conducted interviews with 33 school staff members in five Auburn Park schools. We used a purposeful sampling strategy, selecting schools to maximize variation on dimensions believed important to staff interactions about instruction, including the presence or absence of a mathematics coach and the demographics of the student population (Lincoln and Guba 1985; Patton 1990). Within each school we also purposefully sampled staff to maximize variation in formal position and social-network position. Specifically, we sampled the school principal, the mathematics coach and/or other teacher leaders, and classroom teachers from kindergarten through grade 6. We sampled teachers on their centrality in and integration into school mathematics networks. Sampling schools and staff to obtain such a range of variation on these dimensions allowed us to examine patterns that held across schools and staff positions.
Consistent with our sampling, our goal was not to generate findings that were generalizable to all school staff in Auburn Park but rather to maximize opportunities for verification of our theorizing about instructional interactions among staff. To ensure comparable data were collected across sites while simultaneously allowing respondents to identify issues, we used a semistructured interview protocol organized around five topics: experience at the school, responsibilities at school, nature of instructional interactions with colleagues, influence of interactions on instruction, and observed changes in instructional interaction patterns. Interviews lasted 40 to 50 minutes and were audio recorded, transcribed verbatim, and imported to NVivo 9 for coding and analysis (see below).

Our analysis explored the factors associated with the presence of intra- and interschool ties in language arts and mathematics. First, we built a series of covariate stochastic blockmodels to examine ties between school staff at the same and at different schools within each district. Second, we used a p2 model to explore the school-level factors that predict interschool ties. Third, we explored school leaders’ and teachers’ explanations for their instructional ties based on an analysis of our Auburn Park interview data.

Quantitative Measures and Analysis

*Intra- and interschool networks.*—Using the social-network data, we created the dependent variable for our covariate stochastic blockmodels, which is the existence of an advice or information tie between two school staff members related to language arts or mathematics. For every pair of school staff members $i$ and $j$, if $i$ turned to $j$ for advice about instruction, the $i \rightarrow j$ relationship was assigned a value of 1; otherwise it was assigned a value of 0. Following prior work (Monge and Contractor 2003; Spillane et al. 2012), our independent variables included both individual and organizational characteristics at the school and district levels, and we considered several individual-level (level 2) and dyadic-level (every pair of school staff members, level 1) measures.

Dyad-level (level 1) measures were both within- and between-school covariates:

**Same gender:** This measure took a value of 1 if two school staff members were the same gender and 0 otherwise.

**Same grade:** This dyadic measure took a value of 1 if two teachers taught the same grade and 0 otherwise. If teacher A taught a single or multiple grade levels, teacher B taught a single or multiple grade levels, and there was overlap in the grade levels they taught, then these two teachers taught the same grade.
Same array: This measure was only applicable in Auburn Park, where schools were assigned to one of four arrays for monthly professional-development meetings. Arrays were assigned based on a school’s socioeconomic status, where, for example, all Title I schools were assigned to the same array. This dyadic measure took a value of 1 if two school staff members were assigned to the same array and 0 if they were not.

Although race has been found to be an important predictor of the presence of a social tie between individuals (Spillane et al. 2012), there was not enough variation of this variable in our sample; 99% of school staff members in Auburn Park and 98% in Twin Rivers were white. Individual-level (level 2) measures were staff member attributes, as follows:

Years of experience: Teachers reported the number of years they have been teaching from 0 to 30+. Administrators reported the number of years they taught and their number of years as an administrator, and we used the sum of these two items. Years of experience was thus a continuous variable.

Multigrade teachers: Teachers who reported teaching more than one grade were assigned a value of 1 as multigrade teachers and 0 otherwise. Teachers in this category were special educators, teachers of special areas (e.g., music, art), and reading interventionists.

Formal leaders: We identified school principals as formal leaders and considered other staff members formal leaders if they responded yes to the question: “Are you assigned to a leadership role such as assistant principal, curriculum coach, grade-level team leader, or school-based specialist?” These formal leaders were assigned a value of 1, and those who said no were assigned a 0.

Language arts leader: We used school roster data to assign a value of 1 to language arts leaders, including literacy coaches in Auburn Park and learning facilitators in Twin Rivers.

Math leader: Select teachers in each district participated in a math professional-development program. After completing the program, they were considered math specialists at their schools, and we assigned them a value of 1. In Auburn Park, these teachers also served on the district’s math curriculum committee, or toolbox.

We fit a series of covariate stochastic blockmodels (Sweet, in press) to examine advice or information ties both within and between schools, where the probability of a tie was a function of both group membership and individual- and dyadic-level measures. The covariate stochastic blockmodel is a conditional independence model, where ties are independent of one another conditional on the covariates and school membership. In addition, our covariate stochastic blockmodel explicitly accounts for group or block membership as defined by school assignment; thus, we assume that ties within one’s block are more likely than between-block ties.
The covariate stochastic blockmodel for individual $i$ seeking advice from individual $j$ is as follows:

$$\log \left( \frac{P[i \text{ seeks advice from } j]}{1 - P[i \text{ seeks advice from } j]} \right) = \log \left( \frac{B_{SR}}{1 - B_{SR}} \right) + \alpha_i + \beta_j + \delta_{ij}. $$

In this model, $B_{SR}$ is the probability of a tie from the group that $i$ belongs to the group that $j$ belongs. $B$ is therefore a $g \times g$ matrix, denoting the probability of ties between each pair of groups. For example, the entry $B_{12}$ represents the probability of a tie from any individual from group 1 to any individual in group 2. Thus, the overall probability of a tie is influenced by group membership, individual-level covariates $\alpha$ for advice seekers and $\beta$ for advice providers, and dyad covariates $\delta$. The diagonal of the $B$ matrix includes the within-group tie probabilities. These probabilities can vary, which aligns with variability among schools in their propensities to form ties.

The covariate stochastic blockmodel is flexible in allowing between-school tie probabilities to vary, which is important given that certain schools or clusters of schools may interact at different rates. Most important, the covariate stochastic blockmodel can explicitly separate within- and between-school factors and can model how these factors relate to within- and between-school ties separately.

Because prior research suggests that elementary school staff members interact differently depending on the school subject (Spillane 2000, 2005; Spillane and Hopkins 2013), we examined separate models for mathematics and language arts. We thus built a total of four blockmodels, two for each school district. Note that, when applicable, we included separate covariates for intraschool and interschool ties. The level 1 dyad component of the model is as follows:

$$\delta_{ij} = \gamma_{1s}^{(d)} (\text{same gender and same school})_{ij} + \gamma_{1b}^{(d)} (\text{same gender and different school})_{ij} + \gamma_{2a}^{(d)} (\text{same grade and same school})_{ij} + \gamma_{2b}^{(d)} (\text{same grade and different school})_{ij} + \gamma_{3b}^{(d)} (\text{same array and different school})_{ij}. $$

The coefficient $\gamma_{3b}^{(d)}$ for array pertains only to the Auburn Park data set.

At level 2, we considered individual-level components, partitioning covariates for seekers and providers. Seekers are those individuals asking for advice, whereas providers are those being solicited for advice. The seeker component of the model is as follows:
\[ \alpha_i = \gamma_{1a}^{(a)} (\text{subject-specific leader and same school}), \]
\[ + \gamma_{1b}^{(a)} (\text{subject-specific leader and different school}), \]
\[ + \gamma_{2a}^{(a)} (\text{other leader and same school}), \]
\[ + \gamma_{2b}^{(a)} (\text{other leader and different school}), \]
\[ + \gamma_{3a}^{(a)} (\text{multigrade and same school}), \]
\[ + \gamma_{3b}^{(a)} (\text{multigrade and different school}), \]
\[ + \gamma_{4a}^{(a)} (\text{experience and same school}), \]
\[ + \gamma_{4b}^{(a)} (\text{experience and different school}). \]

The provider component of the model is as follows:

\[ \beta_i = \gamma_{1a}^{(b)} (\text{subject-specific leader and same school}), \]
\[ + \gamma_{1b}^{(b)} (\text{subject-specific leader and different school}), \]
\[ + \gamma_{2a}^{(b)} (\text{other leader and same school}), \]
\[ + \gamma_{2b}^{(b)} (\text{other leader and different school}), \]
\[ + \gamma_{3a}^{(b)} (\text{multigrade and same school}), \]
\[ + \gamma_{3b}^{(b)} (\text{multigrade and different school}), \]
\[ + \gamma_{4a}^{(b)} (\text{experience and same school}), \]
\[ + \gamma_{4b}^{(b)} (\text{experience and different school}). \]

In these models, all variables except same school describe characteristics about the seeker or provider only. Since same school is a dyadic-level variable, we use it to separate within- and between-school interactions.\(^1\)

School-to-school networks.—We also considered several school-level variables that might be associated with between-school advice and information ties. In these, our dependent variable was the existence of a tie occurring at least monthly between staff members at two different schools. For example, if any one teacher from school A interacted with any one teacher from school B monthly or more than monthly (i.e., weekly or daily), then their school-school tie was coded as 1. Again, we included both individual and organizational characteristics as independent variables at level 1 and level 2.

Level 1 (dyad-level) measures were:

**Dissimilarity of school size:** This measure is the absolute difference between two schools in the number of students enrolled. A negative dissimilarity effect indicates that a relation between two similar schools is more likely than between two dissimilar schools (Van Duijn et al. 2004).

**Dissimilarity in the percentage of students receiving free or reduced-price lunches:** The value of this measure is the absolute difference between two schools in their percentages of students receiving free or reduced-price lunches.

**Proximity:** This measure was estimated using Google Maps and represents the distance between two schools in miles.
Level 2 (individual-level) measures were:

**Percent proficient in language arts or mathematics:** Based on prior research showing that principals from higher-performing schools were more likely to interact with other principals than those from lower-performing schools (Daly and Finnigan 2012), we hypothesized schools with higher achievement scores would be more likely to seek out advice or information. Assuming that prior-year achievement would be most informative for current-year ties between schools, we used data from state assessments taken in spring 2012 for students in grades 3 through 6. We included the percentage of students within each school who scored proficient or above on the state assessment in the applicable subject.

**Level of within-school trust:** We hypothesized within-school connections and network closure (i.e., bonding social capital) might facilitate higher levels of within-school trust (Coleman 1988), thus lending to fewer external ties. We calculated the average level of teacher-teacher trust in each school based on five items adapted from the Consortium on Chicago School Research’s (CCSR 2004) Key Measures of School Development (Cronbach’s $\alpha = 0.88$).

We fit two p2 models per school district in StOCNET (Huisman and Van Duijn 2003) to examine the factors that predicted ties between school buildings. A p2 model is essentially a logistic regression model that regresses the dependent variable on various level 1 and level 2 predictors and models the dependence of network ties using random effects (Van Duijn et al. 2004). The p2 model was most appropriate because we only examined the presence of ties between school buildings (interschool ties); as such, these models only included level 1 and level 2 covariates and did not include group membership. In addition to including level 1 and level 2 variables, we included reciprocity to control for the extent to which school $j$ provided advice or information to school $i$. The level 1 (dyad-level) component of the model for the pair of schools $i$ and $j$ is as follows:

$$
\log \left( \frac{P[i \ text{ seeks advice from } j]}{1 - P[i \ text{ seeks advice from } j]} \right) = \alpha_i + \beta_i \\
+ \delta_1(absolute \ difference \ in \ proportion \ of \ students \ receiving \ free \ or \ reduced-price \ lunches)_{ij} \\
+ \delta_2(absolute \ difference \ in \ school \ size)_{ij} \\
+ \delta_3(\text{proximity})_{ij}.
$$

The level 2 (individual-level) model component is as follows:

$$
\beta_i = \gamma_0^{(d)} + \gamma_1^{(d)} (within-school \ trust) + \gamma_2^{(d)} (school \ percent \ proficiency)_{ij}.
$$
Qualitative Data Analysis

Using a combination of open and closed coding (Strauss and Corbin 1998), we analyzed the interview data in three phases. In phase 1, we closed coded all interviews around three macro codes—the how (i.e., ways in which interactions happened), why (i.e., reasons for seeking out particular people), and what (i.e., substance) of teachers’ interactions about instruction. We intentionally used broad codes to attend closely to the interviewees’ perspectives and to avoid imposing our emerging hypotheses based on the literature and the quantitative findings on the interview data. To establish interrater reliability, researchers coded one-third of the interviews independently, met to discuss any coding disagreements, and recoded the data until high kappa coefficients were achieved, ranging from .72 to .99 (Carey et al. 1996; Fleiss 1981). Next, all data categorized under the three macro codes in phase 1 were open coded to identify themes salient to interactions among staff about instruction. In phase 2 we used a combination of in vivo codes (i.e., words used by interviewees) and our own language in identifying themes. We then selected the most prominent themes pertinent to factors associated with having an instructional tie and defined some new codes including perceived expertise, formal leadership position, formal training, and participation in an organizational routine. In phase 3, we applied these codes to the entire interview data set.

We then developed a series of content-analytic summary matrices (Miles et al. 2014) using our coded data to explore and verify our assertions in two ways. First, we identified prominent themes within each macro code, checked to see if they held across schools and positions, and compared these with findings from our quantitative analysis. Second, and most important, as it extended rather than simply corroborated our quantitative analysis, we conducted a series of queries in NVivo 9 to explore the intersection of different phase 3 codes for interpretive analysis exploring, for example, connections between perceived expertise and formal position, or perceived expertise and participation in an organizational routine.

Results

With a few exceptions, Auburn Park and Twin Rivers looked relatively similar with respect to organizational characteristics. In Auburn Park, 22% of survey respondents reported holding some form of leadership position, and 3% each reported being language arts and math specialists (see table 1). In Twin Rivers, 24% of respondents self-reported as formal leaders, and language arts and
math specialists comprised 4% and 2% of respondents, respectively. Auburn Park and Twin Rivers were also similar in the number of teachers teaching multiple grades (24% and 30%, respectively) and in average years of experience (11.8 and 13.3 years, respectively). Still, teachers generally reported having fewer hours of math professional development (PD), and there were fewer math specialists (6 vs. 11), in Twin Rivers than in Auburn Park. In Auburn Park, 2 of the 11 math specialists were math coaches assigned to one school each. In Twin Rivers, there was one math coach who was assigned to all eight of the district’s Title I schools.

With respect to social ties, a necessary condition for the development of social capital, within-school (intraschool) instructional ties were much more prevalent than between-school (interschool) ties in both school districts and in both school subjects. Of the 1,099 advice and information ties related to language arts and 663 ties related to mathematics in Auburn Park, 88% were between staff in the same school (see table 2). Within-school ties were even more prevalent in Twin Rivers, where 95% of the 904 language arts ties and 92% of the 650 math ties were within school. Although the bulk of instructional interactions were within schools in both districts, there was considerable variation between schools within each district: in one Auburn Park school, for example, 27% of mathematics ties were with staff in other schools, whereas in another school none of the mathematics advice and information ties extended outside the school.

To examine the factors that predict inter- and intraschool ties more closely, below we report findings in three stages. We begin by modeling factors that are associated with the occurrence of a tie, a necessary precondition for social capital, between two school staff members both within and between schools.

| TABLE 1 |
|---------|

**School Staff Descriptive Statistics for Auburn Park and Twin Rivers, 2012–2013**

|                  | Auburn Park (N = 389) | Twin Rivers (N = 320) |
|------------------|-----------------------|------------------------|
| Formal leaders, % (n) | 22 (87)               | 24 (77)                |
| Language arts leaders, % (n) | 3 (12)              | 4 (13)                |
| Math leaders, % (n) | 3 (11)                | 2 (6)                  |
| Multiple grade teachers, % (n) | 24 (95)              | 31 (98)               |
| Experience (years) | M = 11.8, SD = 8.7 | M = 13.3, SD = 9.4    |
| PD hours           | <4 4–8 9–16 17–32 33+ | <4 4–8 9–16 17–32 33+ |
| Language arts, %   | 32 31 22 10 5 34 31 18 9 8 |                  |
| Math, %            | 43 29 16 5 7 63 21 8 4 5 |                  |
Next, using our interview data, we explore school leaders’ and teachers’ reasoning about particular instructional advice and information-seeking interactions. Finally, we consider whether characteristics of the school organization (e.g., student achievement levels) might account for ties between schools.

Table 2

Proportion of Ties Within and Between Schools

|            | AUBURN PARK |            | TWIN RIVERS |            |
|------------|-------------|------------|-------------|------------|
|            | Proportion  | Proportion | Proportion  | Proportion |
|            | Within      | Between    | Within      | Between    |
| Literacy:  |             |            |             |            |
| Overall    | .88         | .12        | .95         | .05        |
| Minimum    | .82         | .06        | .88         | .00        |
| Maximum    | .94         | .18        | 1.00        | .12        |
| Math:      |             |            |             |            |
| Overall    | .88         | .12        | .92         | .08        |
| Minimum    | .73         | .00        | .83         | .00        |
| Maximum    | 1.00        | .27        | 1.00        | .17        |

Modeling Intra- and Interschool Instructional Ties in Local School Systems

Using the covariate stochastic blockmodel to estimate the effects of individual- and dyad-level factors, we report parameter estimates for language arts advice and information ties in table 3 and for mathematics ties in table 4. Quantiles from the distributions of estimation samples are reported alongside each parameter estimate to aid interpretation of statistical significance of each covariate in the models. The quantiles between 2.5 and 97.5 define the Bayesian analog to a frequentist confidence interval. Therefore, if the quantiles between 2.5 and 97.5 do not include 0, the estimate will be statistically significant at the 5% level. In our presentation of findings, we focus on results from Auburn Park and refer to Twin Rivers only when patterns differ. We focus mostly on Auburn Park to avoid repetition because of roughly similar quantitative findings and because we also use qualitative data from Auburn Park.

Intraschool Advice and Information Interactions

Within schools, our overall findings confirm prior research (Spillane et al. 2012) and point to the importance of the formal organizational structure in influencing instructional advice and information ties. We found that having a
|                         | **AUBURN PARK** (n = 389) |          |          | **TWIN RIVERS** (n = 320) |          |          |
|-------------------------|----------------------------|----------|----------|---------------------------|----------|----------|
|                         | **Parameter**              | **Quantiles** |          | **Parameter**              | **Quantiles** |          |
|                         | **Est.** | **(SE)** | **2.5** | **97.5** | **Est.** | **(SE)** | **2.5** | **97.5** |
| **Within block:**        |                         |          |          |                           |          |          |
| Dyadic level (Level 1):  |                         |          |          |                           |          |          |
| Same grade              | 2.91* .10               | 2.72     | 3.13     | 2.07* .10               | 1.86     | 2.26     |
| Same gender             | -.21* .08                | -.38     | -.04     | -.43* .08                | -.59     | -.27     |
| Individual level (Level 2): |                         |          |          |                           |          |          |
| Seeker level:           |                         |          |          |                           |          |          |
| Language arts leader    | .21 .25                 | -.32     | .68      | -.01 .22                 | -.46     | .39      |
| Non-LA formal leader    | -.46* .11               | -.66     | -.24     | -.03 .10                 | -.22     | -.19     |
| Multiple grades         | -2.13* .11              | -.66     | -.24     | -1.49* .11               | -1.69    | -1.29    |
| Experience              | -.04* .004              | -.05     | -.03     | -.02* .004               | -.03     | -.02     |
| Language arts PD        | -.18* .03               | -.24     | -.11     | -.16* .03                | -.22     | -.10     |
| Provider level:         |                         |          |          |                           |          |          |
| Language arts leader    | 4.10* .015              | 3.82     | 4.39     | 2.33* .16                | 1.98     | 2.59     |
| Non-LA formal leader    | .19* .09                | .01      | .37      | .53* .09                 | .34      | .71      |
| Multiple grades         | -2.07* .11              | -2.29    | -1.85    | -1.66* .11               | -1.88    | -1.44    |
| Experience              | -.02* .004              | -.03     | -.01     | -.01* .004               | -.02     | -.01     |
| Language arts PD        | -.20* .03               | -.26     | -.14     | -.16* .03                | -.23     | -.09     |
Between block:

### Dyadic level (Level 1):

|                        | .31 | .19 | -.06 | .67 | ... | ... | ... | ... | ... | .06 | .67 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . |
|------------------------|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Same array             | .62*| .21 | .21  | 1.03| .27 | .33 | -.42| .84 |
| Same grade             | -.42*| .19 | -.81 | -.06| -.51| .31 | -1.09| .08 |

### Individual level (Level 2):

#### Seeker level:

|                        | 2.29*| .22 | 1.82 | 2.65| 2.29*| .33 | 1.60| 2.90 |
|------------------------|------|-----|------|-----|------|-----|-----|------|
| Language arts leader   | .55* | .19 | .17  | .89 | -.17 | .41 | -.92| .63  |
| Non-LA formal leader   | -.29 | .20 | -.70 | .10 | -.14 | .32 | -.78| .50  |
| Multiple grades        | -.03*| .01 | -.05 | -.01| -.06*| .02 | -.09| -.02 |
| Language arts PD       | -.10 | .07 | -.24 | .03 | -.04 | .11 | -.28| .17  |

#### Provider level:

|                        | 2.60*| .20 | 2.28 | 3.06| 2.49*| .36 | 1.77| 3.14 |
|------------------------|------|-----|------|-----|------|-----|-----|------|
| Language arts leader   | .23  | .21 | -.17 | .63 | .62* | .31 | .06 | 1.28 |
| Non-LA formal leader   | .07  | .21 | -.48 | .35 | -.07 | .32 | -.68| .61  |
| Multiple grades        | .00  | .01 | -.02 | .02 | -.003*| .02 | -.03| .03  |
| Language arts PD       | .03  | .07 | -.11 | .17 | -.15 | .12 | -.39| .08  |

**Note.**—Non-LA formal leaders are defined as formal leaders who were not designated as language arts leaders.

* $p < .05$.
| Covariate Stochastic Blockmodels for Within- and Between-School Ties, Mathematics |
|----------------------------------|--------------------------------------------------|--------------------------------------------------|
|                                  | AUBURN PARK ($n = 389$)                          | TWIN RIVERS ($n = 320$)                          |
|                                  | Parameter | Quantiles | Parameter | Quantiles |
|                                  | Est.   | (SE) | 2.5 | 97.5 | Est.   | (SE) | 2.5 | 97.5 |
| Within block                     |          |          |      |      |          |      |      |      |
| Dyadic level (Level 1):          |          |          |      |      |          |      |      |      |
| Same grade                       | 3.35*   | .11     | 3.14 | 3.55 | 2.55*   | .12   | 2.31 | 2.77 |
| Same gender                      | -.46*   | .10     | -.63 | -.27 | -.51*   | .10   | -.71 | -.30 |
| Individual level (Level 2):      |          |          |      |      |          |      |      |      |
| Seeker level:                    |          |          |      |      |          |      |      |      |
| Math leader                      | .17     | .29     | -.41 | .74  | .33     | .26   | -.17 | .84  |
| Nonmath formal leader            | -.29*   | .13     | -.53 | -.04 | .14     | .12   | -.10 | .36  |
| Multiple grades                  | -2.85*  | .14     | -3.11| -2.59| -2.49*  | .14   | -2.75| -2.20|
| Experience                       | -.05*   | .01     | -.06 | -.04 | -.03*   | .01   | -.04 | -.02 |
| Math PD                          | -.27*   | .04     | -.36 | -.20 | -.27*   | .04   | -.35 | -.20 |
| Provider level:                  |          |          |      |      |          |      |      |      |
| Math leader                      | 2.05*   | .20     | 1.64 | 2.45 | 1.64*   | .19   | 1.27 | 2.02 |
| Nonmath formal leader            | .38*    | .10     | .18  | .57  | .73*    | .10   | .55  | .95  |
| Multiple grades                  | -2.84*  | .14     | -3.10| -2.55| -2.64*  | .14   | -2.94| -2.39|
| Experience                       | -.02*   | .01     | -.03 | -.01 | -.01*   | .01   | -.02 | -.004|
| Math PD                          | -.27*   | -.04    | -.35 | -.19 | -.28*   | .12   | -.53 | -.03 |
|                      | Dyadic level (Level 1): | Individual level (Level 2): |
|----------------------|-------------------------|----------------------------|
|                      |                         | Seeker level:               |
| Same array           | -.46                    | Math leader                |
|                      | .26                     | 1.43*                      |
|                      | -.96                    | .41                        |
|                      | .05                     | .60                        |
|                      | ...                     | 2.12                       |
|                      | ...                     | 1.47*                      |
|                      | ...                     | .39                        |
|                      | ...                     | .62                        |
|                      | ...                     | 2.21                       |
| Same grade           | 1.00*                   | Nonmath leader             |
|                      | .23                     | .82*                       |
|                      | .56                     | .23                        |
|                      | 1.44                    | .36                        |
|                      | -.46                    | 1.24                       |
|                      | .33                     | -.22                       |
|                      | ...                     | .35                        |
|                      | ...                     | 1.09                       |
|                      | ...                     | .19                        |
| Same sex             | -.14                    | Multiple grades            |
|                      | .24                     | -2.03*                     |
|                      | -.60                    | .36                        |
|                      | .32                     | -2.78                       |
|                      | -.50                    | -1.39                      |
|                      | .27                     | -.49                       |
|                      | ...                     | .32                        |
|                      | ...                     | 1.09                       |
|                      | ...                     | .19                        |
|                      | ...                     | Experience                 |
|                      | -.02                    | -0.02                      |
|                      | .01                     | -.02                       |
|                      | -.04                    | .01                        |
|                      | -.001                   | -.05                       |
|                      | ...                     | .01                        |
|                      | ...                     | Experience                 |
|                      | -.17*                   | -0.17*                     |
|                      | .09                     | -.33                       |
|                      | -.33                    | -.01                       |
|                      | -.28*                   | -.28*                      |
|                      | .12                     | .12                        |
|                      | -.53                    | -.53                       |
|                      | -.03                    | -.03                       |
|                      |                         | Provider level:            |
|                      |                         | Math leader                |
|                      |                         | 3.98*                      |
|                      |                         | .22                        |
|                      |                         | 3.58                       |
|                      |                         | 4.42                       |
|                      |                         | 2.02*                      |
|                      |                         | .4                        |
|                      |                         | 1.20                       |
|                      |                         | 2.75                       |
|                      |                         | Nonmath formal leader      |
|                      |                         | .65*                       |
|                      |                         | .25                        |
|                      |                         | .15                        |
|                      |                         | 1.16                       |
|                      |                         | 1.29*                      |
|                      |                         | .27                        |
|                      |                         | .76                        |
|                      |                         | 1.82                       |
|                      |                         | Multiple grades            |
|                      |                         | -2.11*                     |
|                      |                         | .40                        |
|                      |                         | -2.90                      |
|                      |                         | -1.37                      |
|                      |                         | -.60                       |
|                      |                         | .35                        |
|                      |                         | -1.34                      |
|                      |                         | .01                        |
|                      |                         | Experience                 |
|                      |                         | .04*                       |
|                      |                         | .01                        |
|                      |                         | .06                        |
|                      |                         | .05*                       |
|                      |                         | .02                        |
|                      |                         | .07                        |
|                      |                         | Math PD                    |
|                      |                         | -.48*                      |
|                      |                         | .10                        |
|                      |                         | -.69                       |
|                      |                         | -.28                       |
|                      |                         | -1.5                       |
|                      |                         | .12                        |
|                      |                         | -0.39                      |
|                      |                         | .06                        |

**Note.**—Nonmath formal leaders are defined as formal leaders who were not designated as mathematics leaders.

* $p < .05$. 
formal leadership position, and a subject-specific leadership position in particular, increased the odds of a school staff member being sought out for instructional advice and information within his or her school. While school staff members with formal leadership positions were more likely to provide advice and information than individuals without such positions, we found that subject-specific leaders were much more likely to provide advice than other formal leaders in Auburn Park. For example, the effect of being a language arts leader (4.10) on providing advice and information was greater than the effect of being a non-subject-specific leader (0.33) in the district’s language arts networks, and the effect of being a math leader (2.05) was greater than being a non-subject-specific leader (0.38) in the district’s math networks (see tables 3 and 4). These effects were similar, although smaller, in Twin Rivers.

With respect to within-school advice and information seeking, non-subject-specific formal leaders were, in general, somewhat less likely to seek out advice and information in both language arts and mathematics. Specifically, these leaders in Auburn Park were less likely to seek advice in both language arts and mathematics (−0.46, −0.17) whereas these covariates were not significant in Twin Rivers. Similarly, subject-specific leaders in both districts were not more or less likely than other staff members to seek out instructional advice or information. Given that subject-specific leaders and other formal leaders are considered experts and likely spend more time providing instructional advice and information rather than seeking it, these results are to be expected. Still, these findings overall point to the importance of the formal organizational structure in influencing instructional advice and information providing and seeking behaviors within schools.

Similarly, we found that other aspects of the formal organization were associated with the presence of instructional advice and information ties between staff members at the same school. For instance, teachers who taught the same grade were much more likely to have an instructional advice and information tie, as indicated by a large positive dyadic effect of same grade for language arts (2.91) and mathematics (3.35). Conversely, the small negative dyadic effect of same gender for both language arts (−0.21) and mathematics (−0.46) indicates that being of the same gender slightly decreased the odds of having an instructional advice and information tie. Furthermore, teachers who taught multiple grades were less likely to seek and provide advice and information, as suggested by a negative individual effect of multiple grades taught in language arts (−2.13, −2.07) and mathematics (−2.85, −2.84) in Auburn Park.

Regarding individual-level factors, years of experience had a very small negative effect in language arts (seeker effect: −0.04; provider effect: −0.02) and mathematics (−0.05, −0.02), which suggests that professionals with increasingly more experience were slightly less likely to either provide or seek instructional advice. Similarly, higher levels of professional development were
negatively associated with seeking and providing advice in both language arts \((-0.18, -0.20)\) and mathematics \((-0.27, -0.27)\). These patterns indicate that, although high levels of professional development and experience are often associated with expertise, staff members with more experience and more professional development were generally less likely to seek and provide advice and information than other staff members.

Overall, our findings suggest that, in these two districts, holding a subject-specific leadership position may have been a better indicator of expertise than either experience or professional development. Moreover, the large positive effects of teaching the same grade and the large negative effects of teaching multiple grades suggest that the formal organization as represented by grade-level assignment influenced school staff members’ instructional advice and information interactions and exercised a stronger influence than individual characteristics such as gender or experience.

**Interschool Advice and Information Interactions**

Between schools, we similarly found that the formal organization superseded individual characteristics in forging ties, a necessary if insufficient condition for social capital development. More than anything else, formal leadership predicted advice and information seeking and providing, and the main difference between intra- and interschool findings was that subject-specific leaders both sought and provided instructional advice and information across schools. For example, subject-specific leaders were much more likely to seek advice across schools in both language arts and mathematics \((2.29, 1.43)\) and to provide advice and information to staff in other schools \((2.69, 3.98)\) (see tables 3 and 4). In contrast, while non-content-specific formal leaders were more likely to seek advice in both language arts and mathematics in Auburn Park \((0.63, 0.76)\), they were not in Twin Rivers. Additionally, content-specific formal leaders were only slightly more likely to provide advice in language arts and mathematics in Twin Rivers \((0.62, 1.29)\), but results were less conclusive in Auburn Park.

With respect to other aspects of the formal organization, staff members in Auburn Park were more likely to form advice or information ties with an individual at a different school who taught in the same grade in both language arts and mathematics; however, same-grade assignment was not significant in Twin Rivers. We also found some evidence that years of experience and level of professional development negatively affected the likelihood of seeking or providing advice between schools. In particular, we found negative effects of years of experience on seeking advice related to language arts from staff members in other schools, and on providing advice and information in mathematics.
Similarly, we found negative effects in both districts of mathematics professional development on seeking advice from staff members in other schools, and in Auburn Park on providing advice as well.

*Intra- and Interschool Ties, Expertise, and the Formal Organizational Infrastructure*

Our analysis thus far points to the importance of the formal school organizational infrastructure in facilitating inter- and intraschool advice and information interactions, a necessary condition for social capital development. Below we use our interview data in Auburn Park to explore school staff members’ reasoning about their instructional interactions. Our analysis both supports and extends the findings reported above.

*Perceived Expertise, Formal Leadership Position, and Instructional Interactions*

Our analysis of interview data supports the quantitative analysis and underscores the importance of formal leaders, especially subject-specific leaders, in both within- and between-school instructional advice and information interactions. Kelly, a second-grade teacher at Chamberlain Elementary, explained: “If I have a question about math, well, my number one person is Mary of course, being the math coach. She’s been through a lot of the training, she’s had the desire and the passion for math. . . . I go to her primarily.” Kelly explained that she goes to Mary because of her position as “the math coach” and goes on to link Mary’s coach position with her expertise and training in mathematics. Similarly, Angie, a special-education teacher at Bryant Elementary, explained with respect to going to Emily, the math coach, “Emily really wasn’t our facilitator [last year] . . . just a third-grade teacher. . . . But, now that she’s moved into this math facilitator position, that’s different. . . . She’s been trained in it. And, she’s gone to school for it . . . she knows a lot about math and I trust her that she has a lot of, a wealth of knowledge. . . . She’s the go-to person.” Angie explained that Emily has become “the go-to person” for her in mathematics since she became the math coach and took the training for the position. Carol, a first-grade teacher also at Bryant, offered a similar reasoning for going to the mathematics coach, noting, “She’s taken so many classes. . . . I’ve learned a lot from her . . . different ways to question the kids, different things that you should say to the kids.”

School staff members even identified colleagues who were still working as full-time teachers but had received training to become teacher leaders for
mathematics. Karen, a first-grade teacher at Chavez Elementary, explained that her colleague John has “kind of become a math person to see because he’s taken this extra training that nobody else in the building has done, and I know that he’s interested in math, so he’s just one that I’ve gone to that I know focuses very heavily on math.” Of the 33 school leaders and teachers interviewed, 97% reported that expertise was a key consideration in seeking someone out for instructional advice. Further, 30 of these 33 interviewees associated instructional expertise directly with a leadership position (e.g., math coach, literacy facilitator), and 16 of them explicitly referenced the specialized training associated with that leadership position.

Our analysis then not only supports the importance of formal leadership position but also extends it by capturing how school staff members connected formal position explicitly to expertise in a subject area, which was sometimes also linked explicitly to the accompanying formal training for the position. While school staff members offered other rationales for seeking out people in formal positions, including having a personal connection or the person’s style of interacting, these explanations were not nearly as prominent and were always described in addition to expertise.

Perceived Expertise, Formal Position, and Other Aspects of the Organizational Infrastructure

Formal leadership positions, however, did not work in isolation to facilitate intra- and interschool instructional interactions. Based on our analysis of interview data, we argue that formal positions worked in interaction with other aspects of the organizational infrastructure, especially organizational routines such as grade-level professional learning communities (PLCs) in schools and the district’s array and toolbox routines. At the school level, Auburn Park required teachers to meet once per week in their PLCs to discuss instructional issues, with one meeting a month devoted to language arts, one to math, one to student concerns, and one with a flexible topic. At the district level, school staff members met in arrays for professional development at least twice per year, with arrays including three to four schools with similar student characteristics. Also, the district organized curriculum committees, or toolboxes, that met at least once per month to develop or evaluate district curriculum in particular subject areas. Teachers were nominated by their principals and selected by the district’s director of elementary curriculum for participation on the toolbox. The mathematics toolbox, for example, had 16 teachers representing each grade level K–6 and 12 of the district’s 14 elementary schools. These organizational routines worked in at least three ways to influence instructional advice and information interactions.
First, school staff members’ participation in organizational routines facilitated access to instructional advice and information within schools. At the school level, the grade-level PLC routine facilitated intraschool interactions. Rachel, a kindergarten teacher at Chamberlain Elementary, remarked with respect to the PLC routine: “Our [grade] team plans and we get to collaborate together. . . . Our math coach . . . when we’re planning together if we have a question she’s always there to help . . . she knows a lot . . . more about the curriculum . . . the reason behind . . . the math thing . . . she’s really good about saying . . . ‘Don’t miss this part’ or ‘This is what you really wanna have the kids get out of this.’” In Rachel’s account, the PLC routine not only enabled her to interact with colleagues about mathematics but also provided access to the school’s math coach. Clarissa, a first-grade teacher at Kingsley Elementary, also pointed out how, in the PLC routine, “We do plan every week as a team. And one of our team members . . . was on our math toolbox for two years. And so she had insight into helping planning the curriculum. So that was very helpful.” In Clarissa’s view, the PLC routine enabled her to do instructional planning with colleagues, and the fact that one of her colleagues participated in the district’s math toolbox routine provided her grade-level team with access to advice and information about the mathematics curriculum.

All of our interviewees identified participation in the same school-level organizational routine as important to their instructional advice and information interactions. These findings suggest that the importance of grade-level assignment to school leaders’ and teachers’ instructional interactions may be accounted for by participating in the same school routines: grade-level PLCs. Still, our analysis also uncovered several other mechanisms that might account for the importance of grade level. Fourteen interviewees pointed to having the same responsibilities as a reason for interacting with a colleague about teaching. As was the case in both Auburn Park and Twin Rivers, teachers in the same grade in schools, and increasingly within local school districts, typically teach the same content using the same curricular materials. These arrangements provide both incentives for teachers to seek out advice and information from teachers at the same grade level and common artifacts around which teachers can interact, such as student achievement data and textbooks. Further, teachers in the same grade tend to have classrooms located near one another, and 21 interviewees identified physical proximity (e.g., classrooms are next door) as a reason for interacting with a colleague about instruction.

Second, school staff perceived colleagues’ participation in district-level organizational routines as signaling both their expertise in and access to information about instruction. Katie, a sixth-grade teacher at Chavez Elementary, explained that she goes to “the other sixth-grade teacher because she is on the [district] math toolbox . . . so since those are discussions that she has more often as far as like the curriculum, what it is and why they chose it and where
it’s going, . . . that’s who I go to.” Similarly, Clarissa, a teacher at Kingsley Elementary, explained that “we have had that benefit of having Gabrielle on the toolbox and so she was looked upon as, you know, more of the expert. And she would come back and share everything with us. . . . We kinda felt more in the math loop than maybe some other teams who don’t have that connection piece of somebody on the toolbox in their building.” For Katie and Clarissa, a colleague’s participation in the district-level toolbox routine signaled her expertise in a content area and a reason for seeking her out for instructional advice and information.

Moreover, the district’s array routine provided school staff with access to the advice and information of colleagues and subject-specific leaders at other schools. Laura, a third-grade teacher at Kingsley Elementary, explained, “We have array meetings, and [for example] sometimes we talk about math. . . . We consider that like math training. So we have math coaches throughout the district and they kind of tend to lead some of those meetings.” She also said participation in the array routine gave her access to Mary, the math coach at Chamberlain Elementary: “During our array meetings, if we have questions, she [Mary] presents articles and we have share time and stuff. If there’s questions that I have I feel like, you know, I can share what we’re doing or I can ask . . . in those array meetings.” The array routine afforded opportunities for school staff members at different schools to interact with content experts who worked at different schools, such as the math coach.

Third, organizational routines worked to influence leaders’ and teachers’ instructional interactions by creating opportunities for staff members to have shared professional experiences with colleagues that, in turn, were influential in their advice and information interactions. All school staff members we interviewed suggested that a shared professional experience from participation in the same organizational routine was key for having an advice and information interaction with someone. Specifically, 33 interviewees linked a shared professional experience to participation in the same school-level routine, and 18 tied them to participation in the same district-level routine. Sue, the literacy facilitator at Bryant Elementary, explained that she went to a colleague for advice and information about mathematics “because we were both on toolbox, math toolbox at the same time, so um, probably about four years [ago] I’d say.” Mary, the coach at Chamberlain Elementary, offered a similar explanation, saying she interacted with William, Khloe, and Kelly about mathematics because:

William would be more from working with him on toolbox and just having conversations with him. . . . Khloe, fourth grade, I’ve worked with her on math toolbox for many years. Kelly, I have known her since . . . the second year that I started teaching. She was co-chair at
that time on math toolbox. And that’s when I joined math toolbox. . . . It [math] was my worst subject. . . . It was the one that I dreaded . . . and it totally changed. . . . So she was on math toolbox so when I joined that’s how I came connected with her. And so she was a huge resource through that whole thing. I still go to her. I probably talk to her everyday about math.

Mary’s comments capture how participation with three colleagues on the district’s math toolbox routine at various times in her career resulted in a shared professional experience that continued to influence their interactions with one another about mathematics.

The prominence of formal leadership positions and shared experience due to participation on a district-level routine are illuminated when examining the networks of those school staff members who have between-school ties. Figure 1 captures only those individuals who have between-school ties and displays the language arts and math networks for both Auburn Park and Twin Rivers. It is evident that both formal leaders and subject-specific leaders were disproportionately represented in between-school networks compared to school staff members who did not hold leadership positions. Additionally, subject-specific leaders (black squares) were especially prominent in Auburn Park’s between-school networks, providing advice to other formal leaders and teachers at other schools, and providing and seeking advice and information from one another. In contrast, language arts leaders in Twin Rivers were primarily only connected to one another in the language arts network, with only one connected to a teacher at another school. Only the math coach in Twin Rivers was a between-school actor in the math network, with no other math leaders present. The between-school networks in Twin Rivers were in general sparser than in Auburn Park, suggesting fewer between-school connections in Twin Rivers. Given that Twin Rivers did not have district-level organizational routines like Auburn Park, this contrast between districts supports our findings from school staff interviews and suggests that the district-level routines (i.e., toolboxes and arrays) in Auburn Park supported between-school advice and information interactions.

Our analysis thus far suggests that various aspects of the formal organizational structure are associated with instructional advice and information interactions both within and between schools. In this section, we focus on factors at the system level that might be associated with between-school interactions by examining the school characteristics that predict such ties.

School Characteristics and Instructional Ties That Span Schools

In some cases, we found that characteristics of a school’s student population and of a school’s overall achievement level were significantly associated
with between-school ties (as measured by two teachers at different schools interacting at least monthly). Specifically, schools in both Auburn Park and Twin Rivers that were more similar in their percentages of students receiving free and reduced-price lunches were more likely to have language arts instruc-

**Fig. 1.**—Between-school advice and information networks
tional ties, which is reflected in the negative dyadic-level effects of free and reduced-price lunch dissimilarity (−0.07 for Auburn Park, −0.08 for Twin Rivers; see tables 5 and 6). The same effect was evident in mathematics in Twin Rivers (−0.08), but not in Auburn Park (−0.03). Additionally, although schools in Auburn Park with higher average proficiency on the state mathematics test were less likely to seek mathematics advice from other schools (−0.14 seeker effect), we did not find similarly significant results for language arts or in Twin Rivers. We also did not find significant effects of school size, level of within-school teacher-teacher trust, or proximity in either school district.

These findings suggest that staff members in schools with similar student populations tended to share instructional advice and information more often than teachers in schools with dissimilar populations. In Auburn Park, this finding may be at least in part an artifact of the array organizational routine that brings together schools’ staff members from schools with similar student populations. Moreover, in Auburn Park’s mathematics network, higher-performing schools tended to “keep to themselves” and were less likely to seek external advice or information than lower-performing schools. It is possible, indeed likely, that lower-performing schools in Auburn Park received more attention and resources from the district office, thereby encouraging staff to seek advice outside their schools. Assuming that higher-performing schools have expertise that could enable instructional improvement, then the fact that these schools keep to themselves impedes system learning and system-wide instructional improvement.

Discussion and Conclusion

Scholars and policymakers recognize the importance of school organizations and education systems that enable practitioner learning and the ongoing production of knowledge about instruction. Research over the past quarter century has documented the important role of social capital in these efforts, showing how social ties provide access to resources including trust, information, and materials that can enable instructional improvement in schools. Recognizing the scarcity of empirical knowledge on those factors associated with the presence of social ties and the limited attention to ties that go beyond a particular school, we explored factors associated with instructional advice and information ties both within schools and between schools.

Our study contributes to the literature in two broad ways. Our work replicates a handful of prior studies on those factors associated with school staff having an intraschool tie about instruction. Consistent with some prior work (Moolenaar et al. 2014; Small 2009; Spillane et al. 2012), our analysis suggests
TABLE 5

*p2 Models for at Least Monthly Between-School Ties, Language Arts*

| Parameter Quantiles | AUBURN PARK (n = 14) | TWIN RIVERS (n = 14) |
|---------------------|----------------------|-----------------------|
|                     | Est. (SE) 2.5 97.5    | Est. (SE) 2.5 97.5    |
| Seeker variance     | 1.68 1.26 .29 4.98   | 2.64 3.62 .14 12.55  |
| Provider variance   | 1.27 .98 .21 3.76    | .40 .39 .06 1.50     |
| Covariance          | 1.24 .99 .13 3.79    | .15 .91 -1.51 2.22   |
| Density             | 1.43 6.20 -1.51 13.92| -5.49 6.86 -2.0 7.7  |
| Reciprocity         | 1.16 .72 -.28 2.49   | 1.77 1.44 -1.13 4.50 |

Dyadic level (Level 1):
- Free and reduced-price lunch dissimilarity: $-0.07^{*} , 0.02 , -0.12 , -0.02$
- Size dissimilarity: $-0.00 , 0.00 , -0.01 , 0.00$
- Proximity: $-0.06 , 0.07 , -0.31 , 0.15$

Individual level (Level 2):
- Seeker level:
  - % Proficient: $-0.08 , 0.07 , -0.22 , 0.06$
  - Teacher-teacher trust: $1.21 , 1.37 , -1.54 , 3.79$

Demaince: 132.4
Bayesian information criterion (BIC): 309.3
Newton-Raftery p4: -82.8
Log-likelihood: -75.8

* $p < .05$. 


| Parameter                              | AUBURN PARK (n = 14) | TWIN RIVERS (n = 14) |
|----------------------------------------|----------------------|----------------------|
| Parameter                              | Quantiles           | Parameter            | Quantiles            |
| Est. (SE)                              | 2.5 97.5             | Est. (SE)            | 2.5 97.5             |
| Seeker variance                        | .73 .77 .08 2.86     | 6.86 1.67 .23 38.07 |
| Provider variance                      | 1.52 1.32 .16 5.00  | .87 1.16 .07 4.32   |
| Covariance                             | .17 .81 -1.37 2.04  | -1.13 3.20 -1.41 2.28 |
| Density                                | .68 5.65 -9.50 12.52| 4.03 6.56 -8.59 18.00 |
| Reciprocity                            | 1.17 1.11 -.93 3.32 | 2.72 2.04 -.73 7.38 |
| Dyadic level (Level 1):                |                      |                      |
| Free and reduced-price lunch dissimilarity | -.03 .02 -.07 .01 | -0.08* .03 -.15 -.02 |
| Size dissimilarity                     | -.01 .00 -.01 .00  | -.00 .01 -.01 .01   |
| Proximity                              | -.08 .02 -.04 .06   | .02 .21 -.06 .04    |
| Individual level (Level 2):            |                      |                      |
| Seeker level:                          |                      |                      |
| % Proficient                           | -.14* .05 -.24 -.05 | -.02 .05 -.13 .09   |
| Teacher-teacher trust                  | 2.11 1.42 -.81 4.91 | 1.41 1.62 -4.93 1.60 |
| Deviance                               | 9.2                  | 46.0                 |
| Bayesian information criterion (BIC)   | 267.2                | 222.9                |
| Newton-Raftery p4                      | -39.7                | -35.8                |
| Log-likelihood                         | -33.7 4.0            | -29.6 4.1            |

* p < .05.
that while the individual characteristics of gender and experience are associated with the presence of instructional advice and information ties within organizations or schools, aspects of the formal organization are much more strongly associated with such ties. Specifically, the formal organization of teaching assignment (i.e., same-grade and multiple-grade assignment vs. single-grade assignment) and holding a formal leadership position, especially one focused in a particular content area, has a stronger relationship with the presence of a tie in both mathematics and language arts among staff within schools. This empirical replication is essential if we are to amass an empirical body of knowledge to inform policy and practice (Makel and Plucker 2014).

In addition to replicating prior work, our study extends the knowledge base in at least four ways. First, unlike prior studies that examine intra- or interschool ties, we attend to both intra- and interschool instructional ties simultaneously, and we do so for all staff and all elementary schools in two school districts. Second, although a few studies have examined interschool ties, those that have examined ties between schools are too narrowly focused on school principals as the critical nodes. Our work demonstrates that school principals are not the only connectors between schools within districts, and they are not the most important. Having a formal leadership position predicted instructional advice and information ties about mathematics and language arts instruction most, with formal leaders more likely to both seek and provide instructional advice and information between schools. Moreover, being a mathematics- or language-arts-specific leader increased the likelihood of providing instructional advice and information in that subject to staff in other schools. Taken together, these findings point to the importance of formal organizational arrangements (not just individual attributes) in teachers’ and school leaders’ inter- and intraorganizational advice and information ties about teaching.

Third, based on our qualitative data, we theorized the mechanisms that account for relations between formal structure (i.e., formal position, formal routine) and school staff members’ instructional interactions. Specifically, we hypothesized that formal leadership positions and training signal to school staff where expertise resides in their organization and school system; they perceive people in these positions as having expertise. Scholars use the construct of “transactive memory” to refer to people’s use of knowledge encoded externally (e.g., in formal positions) to access where expertise resides (Moreland and Argote 2003; Wegner 1986, 1995). School staff associated leadership positions and the specialized training that came with these positions with having expertise about instruction. Transactive memory is fundamentally about knowing who knows what in an organization or system. By creating formal positions and investing in formal training, school systems can shape the transactive memory of their staffs. Similarly, district-level organizational routines influence transactive memory by signaling to staff that those who participated in these
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routines had particular expertise and access to information. Whether these individuals actually have the expertise that school actors believe they have is an important question for future research. Our qualitative data analysis suggests that physical proximity may also influence teachers’ advice- and information-seeking behavior. Considering that teachers in the same grade typically have adjacent classrooms, future work will have to tease apart how various aspects of same grade-level assignment—physical proximity, participation in the same organizational routines, teaching the same curricular material—influence instructional interactions.

Our analysis also shows that characteristics of the student population of a school appear important when it comes to ties between schools: schools with similar proportions of students from the same socioeconomic background were more likely to have ties, and schools with higher-performing students were less likely to seek external advice or information. These findings may be related to school leaders’ and teachers’ desire to share advice and information with schools that face similar challenges to improving instruction in core subjects. Additionally, staff members in lower-performing schools and schools with students from lower socioeconomic backgrounds may be more likely to interact because there is heightened pressure on these schools to seek out resources that would facilitate instructional change and improvement. Fourth, we make unique methodological contributions in a new model for examining networks in multiple schools simultaneously and by illustrating how qualitative data can be used not only to corroborate quantitative SNA findings but also to extend them.

Social ties are a necessary but not sufficient condition for social capital development. Future research will need to differentiate between intra- and interschool advice and information ties that do and do not contribute to the development of new instructional knowledge and, in turn, to changes in instructional productivity as measured by gains in student learning outcomes. Using longitudinal social-network data, scholars can identify not only those factors associated with the presence of an advice and information tie but also the effect of new ties on teachers’ knowledge and practice and, indeed, student learning outcomes. Doing so will enable us to distinguish ties that enable teacher learning from ties that do not (Moolenaar et al. 2011).

Our analysis does offer some guidance for policymakers and administrators interested in developing social capital. One lesson is that formal organizational structures do matter and matter more than individual characteristics when it comes to advice and information ties among elementary school staff about teaching mathematics and language arts. Because formal leaders in general, especially subject-specific formal leaders, are more likely to provide instructional advice or information, administrators should exercise care in selecting individuals, considering these individuals’ central role in the social networks at both the school and system levels. Selecting not only individuals
with a deep knowledge of instruction but also those whose instructional beliefs and expertise are consistent with school or system instructional-improvement initiatives is more likely to contribute to the successful implementation of system and school improvement efforts.

Our analysis suggests that administrators keen on developing social capital should also weigh decisions about teaching assignments carefully, considering that same grade is associated strongly with instructional ties and that teachers who teach multiple grades are less likely to provide or seek advice in schools. Decisions about grade-level teaching assignments are often based on teachers’ experience or ability in working with a particular age group (e.g., primary vs. senior grades) or ensuring that teachers work in grades with colleagues they get along with. But, based on our analysis, administrators should also take into account the instructional expertise of teachers in assigning them to particular grades, as distributing more expert teachers across grades is more likely to ensure that the advice and information of the most expert teachers in a particular school subject is available to other staff members. Further, by selectively reassigning teachers to different grades from one year to the next, administrators may be able to forge new ties about teaching among their staff over time. We recognize there are trade-offs here in that administrators also have to take into account the fact that some teachers are more effective with particular grades—early versus later elementary grades—and that moving to a different grade increases a teacher’s preparation time. Our analysis of interview data also suggests that although physical proximity and responsibility for similar curricular material help to account for the importance of same grade assignment to ties about instruction, this is only part of the story. Participation in the same organizational routines—grade-level PLC routines—was prominent in school staff members’ reasoning about instructional advice and information interactions. Finally, district administrators working toward district-wide instructional improvement might think strategically about facilitating interactions between schools to ensure that school leaders and teachers have opportunities to interact with others from similar and different schools. It seems important for schools at different performance levels to share instructional advice and information to ensure that instructional expertise is diffused across the school system rather than clustered in particular types of schools.

Limitations

Our analysis has limitations. First, because we rely on a cross-sectional analysis, we are unable to identify causal relations between particular variables (e.g., grade-level assignment) and the existence of an advice or information tie. Moreover, because we report on only one time point, we do not account for
stability or instability of school staff networks and advice and information ties over time. Our analysis also focuses on the presence or absence of advice or information ties; thus, we cannot make claims about the content or quality of that advice or information or whether it facilitated changes in practice. Additionally, there is a limitation inherent to statistical models for inference: it is possible that unobserved factors influence patterns of instructional advice and information interactions. Finally, our analysis has limited generalizability because we rely on data from two school districts in one state, although small samples are typical in theory-building research. Consistent with that tradition, our data include all elementary schools from two school districts in the same state, enabling us to maximize variation within each district on conditions that might account for the presence of advice or information ties.

Notes

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1. We used a Markov Chain Monte Carlo (Gelman et al. 2004) model-fitting algorithm coded in R (R Core Team 2015) to fit these models. A common algorithm in Bayesian analysis, MCMC updates parameters based on the current values of other parameters in the model. Taken together, the updates result in samples that approximate the posterior distribution of each parameter. Parameters are updated using a mix of Gibbs and Metropolis steps (for additional details, see Sweet, in press).

2. The p2 models also utilized an MCMC algorithm to estimate model parameters.

3. All names are pseudonyms.

4. There is empirical evidence to suggest that performance is higher in groups where members are aware of who knows what information (Hollingshead 1998; Wegner 1995; Wegner et al. 1991).

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