

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

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Abstract

Understanding those factors associated with the existence of a tie among school staff is important because such ties are a necessary condition for social capital. Yet, there is a dearth of research on those factors associated with the existence of these ties. In this paper, we use covariate blockmodels and a p2 model to examine the role of both formal organizational structures and individual characteristics in shaping advice and information interactions about instruction *within* and *between* schools. Our findings suggest that, while individual characteristics are significantly associated with having a *within* school tie, aspects of the formal school organization—grade-level assignment, having a formally designated leadership position, and teaching a single grade—are also significant and have larger estimated effects than individual characteristics. With respect to *between* school ties, we similarly found that the formal organization superseded individual characteristics, and that having a subject-specific formal leadership position, more than anything, predicted instructional advice and information ties. In addition, our analysis of interview data supports and extends these findings by showing that school staff associate formal positions with instructional expertise in subject-specific domains and that formal positions work in tandem with other aspects of the organizational infrastructure such as organizational routines to influence school staff members' interactions about instruction.

Introduction

An expanding literature points to the importance of social relations in organizations including in 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 & Schneider, 2002; Coburn, 2001; Daly, Moolenaar, Bolivar, & Burke, 2010; Frank, Zhao, & Borman, 2004; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Louis, Marks, & Kruse, 1996; Moolenaar, Karsten, Slegers, & Daly, 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 & Pil, 2006; Pil & Leana, 2009). Research suggests a relationship between a school's social capital and school performance including reform implementation, parental satisfaction, student attendance and achievement, and teacher commitment (Penuel et al., 2010; Penuel, Riel, Krause, & Frank, 2009; Supovitz, Sirinides, & May, 2010).

Yet, there are gaps in the empirical knowledge base on social capital in schools. First, the literature has largely focused on the returns from social capital, while the mechanisms that account for social capital formation remain largely unexplored (Coburn, 2001; Small, 2010; Spillane, Frank, & Kim, 2012). Social ties are neither “a natural given” nor “a social given” (Bourdieu, 1986, p. 249). Thus, it is essential to understand those factors associated with the formation of social ties, a necessary condition for access to social resources, so that research can inform efforts to build social capital.

Second, most research focuses on social relations *within* schools among students and among staff (Coburn, Russell, Kaufman, & Stein, 2012; Daly et al., 2010; Frank et al., 2004;

Frank et al., 2011; Hallinan, 2007; Leana & Pil, 2006; Moolenaar, Daly, & Slegers, 2011; Moolenaar et al., 2014; Pil & Leana, 2009; Spillane, Kim, & Frank, 2012). While these *intra-school* relations are important (Coburn, 2001; Penuel et al., 2010; Pil & 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 & Kwon, 2002; Burt, 2000). Additionally, research shows that 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 & Kasarda, 1987; Small, 2009). Attention to both internal and external ties is relevant for schools because these organizations are nested in local school districts. Though arrangements differ between and within states, the school district is the primary administrative unit for delivering education in the US, collecting local taxes and having primary responsibility for managing most state and federal funding (Kirst & Wirt, 2009; Tyack, 1974). Further, 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, Crowson, & Shipps, 2011). Yet, few studies examine both intra- and inter-school relations within school districts (for exceptions, see Coburn & Russell, 2008; Daly & Finnigan, 2012; Hite, Williams, & Baugh, 2005; Hite, Williams, Hilton, & Baugh, 2006).

In this paper, we examine intra- and inter-school social relations using data from 28 elementary schools in two US school districts in one mid-western 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, Brown, & Cocking, 2000), and this knowledge in turn 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 in order to identify those factors associated with the existence of intra- and/or inter- school 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.

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 different forms such as goods and services, trust, information, and social obligation (Coleman, 1988; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998), and individuals and organizations can invest in, and benefit from, social capital (Ibarra, Kilduff, & Tsai, 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 inter-school 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 such as 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 & Dreeben, 1983; Bidwell, 1965; Bidwell & Kasarda, 1987; Cohen, 1988; Meyer & 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 & 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 different information that potentially enables knowledge development (Coburn, 2001; Daly & Finnigan, 2010; Frank et al., 2004; Frank et al., 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, research points to the role of social capital in enabling instructional reform and school improvement (Bryk & Schneider, 2002; Frank et al., 2004; Louis & Kruse, 1995; McLaughlin & Talbert, 2001; Rosenholtz, 1991; Smylie & Hart, 1999). Scholars have theorized and empirically documented teachers' on-the-job learning from interactions with peers (Eraut & Hirsh, 2007; Frank et al., 2004). Teachers create learning opportunities when they share expertise, talk about new material, and discuss effective teaching (Brownell, Yeager, Rennells, & Riley, 1997; Davis, 2003; Little, 2003; Smylie, 1995). Strong ties can enhance teacher

commitment and contribute to a sense of belonging and efficacy (Grotsky & Gamoran, 2003).

Higher levels of teacher interaction have also been associated with higher student achievement in both mathematics and language arts, after controlling for school and individual factors (Goddard, Goddard, & Tschannen-Moran, 2007; Pil & Leana, 2009). One recent study showed that teachers who interact do indeed learn from one another, with teachers who have more effective peers being more effective themselves; teachers' learning from peers accounted for 20 percent of the variation in their instructional effectiveness (Goldhaber & Hansen, 2010; Jackson & Bruegmann, 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 & Pil, 2006). The internal dimension refers to relations within the organization (i.e., intra-organizational relations), whereas the external dimension refers to ties that reach beyond the immediate organization (i.e., inter-organizational relations).

Several factors predict social ties within organizations. At the individual level, people tend to interact with similar others in terms of age, race, gender, education, and values (McPherson, Smith-Lovin, & Cook, 2001; Monge & Contractor, 2003). Research offers empirical support for this *homophily* theory, especially with respect to race/ethnicity (Mollica, Gray, & Trevino, 2003; Shrum, Cheek, & Hunter, 1988), education (e.g., Marsden, 1987)(Marsden, 1987), gender (Ibarra, 1992; Leenders, 1996), 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 and constrain these interactions (Blau, 1955; Blau & 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 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.

Though important, internal social capital can also have a downside because close ties can promote conformity among organizational members that is counter-productive (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 group think (Hansen, 1999; Krackhardt & Stern, 1988). Such inter-organizational ties complement intra-organizational (internal) ties by providing new information, which is then combined and used internally via 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 examine the mechanisms that account for the presence of internal and external ties among school staff. The limited scholarship on intra- and inter-school 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 & McEvily, 2003, p. 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 & 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 & Finnigan, 2012). The present study adds to this body of work by simultaneously examining intra- and inter-school relations and the factors that influence them.

Methods

Our analysis is based on data from a longitudinal study in two mid-sized Midwestern school districts we refer to as Auburn Park and Twin Rivers. All elementary school teaching and administrative staff members filled out a School Staff Questionnaire (SSQ) every spring between 2010 and 2013. We use data here from the social network items on the SSQ in 2013, when response rates were highest, to explore intra- and inter-school advice and information-ties in language arts and mathematics.

Auburn Park is a suburban school district serving a predominantly white population, and Twin Rivers is a rural school district that serves a larger Latino/a student population and more students receiving free or reduced-price lunches (see Table 1). During the 2012-2013 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.

Table 1. Elementary School Descriptive Statistics for the 2012-2013 Academic Year

Variable	Mean	SD	Min	Max
Auburn Park (n=14)				
Number of students	418	91	250	601
Free and reduced-price lunch eligible students (%)	25	18	5	59
White students (%)	82	8	67	92
Latino/a students (%)	6	4	2	16
African American students (%)	5	3	2	13
Twin Rivers (n=14)				
Number of students	325	98	116	457
Free and reduced-price lunch eligible students (%)	68	24	16	95
White students (%)	47	25	7	89
Latino/a students (%)	45	25	7	87
African American students (%)	4	3	0	10

In spring 2013, 384 of the 410 school staff members in Auburn Park 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 the 382 school staff responded to the survey varying from 68% to 96% by school, with an overall response rate of 83%. Seven percent of respondents in Auburn Park reported having full-time formal leadership positions (e.g., principal, literacy coach), 69% reported teaching a single-grade, and 24% reported teaching multiple grades. In Twin Rivers, 5% of respondents were full-time formal leaders, while 63% were single-grade teachers, and 28% taught multiple grades. We conducted interviews with a purposeful sample of 34 school leaders and teachers in a purposeful sample of five Auburn Park schools selected to maximize variation on dimensions believed important to school staff instructional ties (e.g., presence or absence of a mathematics coach, student population served). Interviews lasted between 40-50 minutes and were audio recorded, transcribed verbatim, and imported to NVivo 9 for coding and analysis.

We explored the factors associated with the presence of intra- and inter-school ties in language arts and mathematics in three steps. First, we built a series of covariate blockmodels to examine ties between school staff at the same and at different schools within each district. Second, we explored school leaders' and teachers' explanations for their instructional ties using a descriptive analysis of our interview data from Auburn Park. Third, we used a p2 model to explore the school-level factors that predict inter-school ties.

Measures

School Staff Advice and Information Networks Within and Between Schools

To examine advice and information ties between school staff members at the same and at different schools, we used social network survey items that were developed, and validated in other studies (Pitts & Spillane, 2009; Pustejovsky & Spillane, 2009). Specifically, we asked respondents: 'During this school year, to whom have you turned to for advice and/or information about curriculum, teaching, and student learning'? Survey respondents listed up to 12 individuals, and these names were auto-populated in a follow-up question that asked respondents to indicate the content area for which they sought advice and/or information from each person, including reading/English language arts (which we refer to as "language arts") and mathematics.

Using these data, we created the dependent variable for our covariate 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 i and j , if i turned to j for advice about instruction, the $i \rightarrow j$ relationship was assigned a value of 1 and 0 otherwise. We considered several individual-level (Level 2) and dyadic-level (every pair of school staff members, Level 1) measures as independent variables. Individual-level measures refer to attributes of individual staff members (e.g., a formal leader), whereas dyadic-level measures

focus on similarities and differences between any two staff members (e.g., same grade taught). Following prior work (Monge & Contractor, 2003; Spillane et al., 2012), we examined both individual and organizational characteristics at both the school and district levels.

We measured the following at the individual level (Level 2) when building the covariate blockmodels:

- *Career stage*: We recoded responses to the question, “How many years have you worked as a teacher?” using six categories (1 = 0–3 years, 2 = 4–6 years, 3 = 7–11 years, 4 = 12–20 years, 5 = 21–30 years, and 6 = more than 30 years).
- *Multi-grade teachers*: Teachers who reported teaching more than one grade were coded as multiple-grade teachers. Teachers in this category included special education and speech teachers, teachers of special areas (e.g., music, art), and reading interventionists.
- *Formally designated leaders*: We identified all school principals as formal leaders, and we considered other school staff members as 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?”
- *Language arts specialists*: We used school roster data to identify language arts specialists, including literacy coaches in Auburn Park and learning facilitators in Twin Rivers.
- *Math specialists*: Select teachers in each district participated in a mathematics professional development program. After completing the program, they were considered math specialists at their schools.

To estimate the effects of dyadic-level (Level 1) covariates both within and between schools, we used two variables: gender and grade level. We also used one dyadic-level variable to examine ties between staff members at different schools in Auburn Park: array assignment.

This organizational feature existed only in Auburn Park We operationalized these measures as follows:

- *Same gender dyadic covariates*: This measure indicator takes a value of 0 if two school staff members were different genders, 1 if they were the same gender.
- *Same grade dyadic covariates*: This dyadic measure takes a value of 0 if two teachers did not teach the same grade, 1 if they taught the same grade. If teacher A teaches a single or multiple grade levels and teacher B teaches a single or multiple grade levels, and there is overlap in the grade levels they teach, then these two teachers teach the same grade level.
- *Same array dyadic covariate*: For Auburn Park, this dyadic measure takes a value of 0 if two school staff members were not assigned to the same array and 1 if they were assigned to the same array.

School-to-School Networks

In addition to examining the intra- and inter-school advice and information networks among school staff members, we considered the school-level variables associated with advice and information ties between school buildings. Using a p2 model, our dependent variable was the existence of a tie between two schools related to language arts and mathematics. As above, independent variables included both individual-level (Level 2) and dyadic-level (Level 1) measures.

Individual-level measures (Level 2) included two variables:

- *Percent proficient in language arts or mathematics*: Assuming that prior year achievement would be most informative for current year ties between schools, we used data from the state assessments taken in spring 2012 for students in grades 3-6. We included the percentage of

students within each school who scored proficient or above on the state assessment in the appropriate subject-matter model.

- *Level of within-school trust*: 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 (2004) Key Measures of School Development (Cronbach's $\alpha = 0.88$). The average score across the five items for each teacher were calculated, and then the average for each school.

Dyadic-level measures (Level 1) included two variables:

- *(Dis)similarity of school size*: This measure is the absolute difference between two schools in their number of students enrolled. A negative (dis)similarity effect indicates that a relation between two similar schools is more likely than between two dissimilar schools (Van Duijn, Snijders, & Zijlstra, 2004).
- *(Dis)similarity in the percentage of students receiving free or reduced-price lunches*: The value of this dyadic measure is the absolute difference between two schools in their percentages of students receiving free or reduced-price lunches.

Quantitative Data Analysis

The Covariate Blockmodel

To examine advice-seeking relationships within and between schools, we fit a covariate blockmodel (Sweet, Thomas, & Junker, 2014) in which the probability of a tie is a function of both group membership and level 1 and level 2 measures. The covariate blockmodel, similar to the p2 model (Van Duijn et al., 2004), is a conditional independence model, where ties are independent of one another conditional on the covariates in the model. Because social network data do not satisfy the assumption of independent observations, where the tie from teacher A to

teacher B is not independent of a tie from teacher B to teacher A, simple logistic regression is not appropriate (Van Duijn & Vermunt, 2006), and the conditional independence model is necessary.

Unlike the p2 model, however, the covariate blockmodel explicitly accounts for group membership so that both within-group and between-group ties are modeled. Moreover, the p2 model assumes equal conditional tie probabilities and, in a network consisting of distinct schools, we expect within-school or within-group ties to be more common than between-school ties. A blockmodel which assumes that within-block tie probabilities are higher than between-block tie probabilities is thus most appropriate. For our analysis, we augmented the standard blockmodel (Wang & Wong, 1987) to include covariates.

The Level 1 covariate blockmodel model for individual i seeking advice from individual j is given as:

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

In this model, B_{S,R_j} 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 as well as seeker covariates α , provider covariates β , and dyad covariates δ . As described above, these covariates include both dyadic-level and individual-level variables along with within-group and between-group variables.

It is important to note that 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. These probabilities are thus analogous to having a random effect for density in the p2 model, which is not a standard feature in p2 model- fitting software.

Additionally, the covariate 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 importantly, the covariate blockmodel can explicitly separate within-school and between-school factors and can model how these factors relate to between-school and within-school ties separately.

Because prior work suggests that teachers organize for instruction in elementary schools differently depending on the school subject (Spillane, 2000, 2005; Spillane & Hopkins, 2013), we examine separate models for mathematics and language arts. We thus built a total of four block models, two for each school district. Note that, when applicable, we included separate covariates for intra-school and inter-school ties. The dyad component of the model is therefore formalized as:

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

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

At level 2, we consider the node-level components of the model separately, partitioning our covariates for seekers and providers. Seekers are those individuals asking for advice, whereas providers are those being solicited, thereby providing the advice. We included a comprehensive list of covariates because we were interested in exploring many factors that may be associated with between-school ties, but also to determine whether additional factors are relevant since these data are different from those used in prior work (Spillane et al., 2012). For each content area, we separate subject-matter specialists from the other formal leaders in the

school to examine the importance of subject-specific leaders in intra- and inter-school networks.

The seeker component of the model is given as:

$$\alpha_i = \gamma_{1a}^{(\alpha)} (\text{subject-specific leader and same school})_i + \gamma_{1b}^{(\alpha)} (\text{subject-specific leader and different school})_i + \gamma_{2a}^{(\alpha)} (\text{other leader and same school})_i + \gamma_{2b}^{(\alpha)} (\text{other leader and different school})_i + \gamma_{3a}^{(\alpha)} (\text{multi-grade and same school})_i + \gamma_{3b}^{(\alpha)} (\text{multi-grade and different school})_i + \gamma_{4a}^{(\alpha)} (\text{career stage and same school})_i + \gamma_{4b}^{(\alpha)} (\text{career stage and different school})_i .$$

In this model, all variables except same school describe characteristics about the seeker only.

Since same school is a dyadic-level variable, we use it to separate within- and between-school

interactions in the models. The next component of the blockmodels examines attributes of the

individuals being sought for advice, or advice providers. The provider component of the model is

given as:

$$\beta_i = \gamma_{1a}^{(\beta)} (\text{subject-specific leader and same school})_i + \gamma_{1b}^{(\beta)} (\text{subject-specific leader and different school})_i + \gamma_{2a}^{(\beta)} (\text{other leader and same school})_i + \gamma_{2b}^{(\beta)} (\text{other leader and different school})_i + \gamma_{3a}^{(\beta)} (\text{multi-grade and same school})_i + \gamma_{3b}^{(\beta)} (\text{multi-grade and different school})_i + \gamma_{4a}^{(\beta)} (\text{career stage and same school})_i + \gamma_{4b}^{(\beta)} (\text{career stage and different school})_i .$$

To fit these models, we used a Markov Chain Monte Carlo (Gelman, Carlin, Stern, & Rubin, 2004) model-fitting algorithm coded in R (R Development Core Team, 2011). 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 et al., 2014).

School-to-School Networks

For the second stage of the quantitative analysis, we examined the factors that predicted ties between school buildings using p2 network selection models. The p2 model was most appropriate here because we only examined ties present between school buildings (inter-school ties); as such, these models only included level 1 and level 2 covariates and did not include group membership like the blockmodels.

Like the covariate blockmodel, the p2 model expresses the pattern of observed ties as a function of dyadic-level characteristics at level 1 and individual-level characteristics at level 2. At level 1, we included two dyadic-level characteristics, the absolute difference between two schools' percentage of students receiving free or reduced-price lunches and between two schools' sizes. We also included reciprocity to control for the extent to which school j provided advice or information to school i . The dyad component of the model for the pair of schools i and j is formalized as:

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

The term δ_2 indicates the extent to which schools with similar proportions of students receiving free or reduced-price lunches exchanged advice or information, and the term δ_3 indicates the extent to which schools of similar sizes exchanged advice or information.

At level 2, we estimated node-level attributes, with within-school trust and a school's percent proficiency included as seeker effects. With respect to trust, we hypothesized that within-school connections and network closure (i.e., bonding social capital) might facilitate higher levels of within-school trust (Coleman, 1988), thus leading to fewer external ties. Based on prior research showing that school principals from higher-performing schools were more likely to

interact with other principals than those from lower-performing schools (Daly & Finnigan, 2012), we also hypothesized that schools with higher achievement scores would be more likely to seek out for advice or information. The seeker component of the model is given as:

$\beta_i = \gamma_0^{(\beta)} + \gamma_1^{(\beta)} (\text{within-school trust})_i + \gamma_2^{(\beta)} (\text{school percent proficiency})_i$. The p2 models were fit using StOCNET (Huisman & Van Duijn, 2003), which also utilizes an MCMC algorithm to estimate model parameters.

Qualitative Data Analysis

The interview data coding included three phases. In Phase one, we close coded all interviews around three macro codes – the how, why, and what of social interactions. In Phase two, we open coded (Strauss & Corbin, 1998) all data coded under the three macro codes to identify salient themes, selecting the most prominent and defining these codes for another round of closed coding. In Phase three, we applied these codes to the entire data set. To establish inter-rater 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, Morgan, & Oxtoby, 1996; Fleiss, 1981). We then used various functions of NVivo 9 to identify the prominence of particular codes *and* to generate reports for interpretive analysis at the intersection of different codes.

Results

Within-school (intra-school) instructional ties were much more prevalent than between-school (inter -school) ties in both school districts. 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-

schools. While the bulk of instructional interactions were within schools, there was considerable variation within the two school districts: In one Auburn Park school, for example, 27% of mathematics advice and information ties were with staff in other schools (inter-school ties), whereas in another school none of the mathematics advice and information ties extended outside the school.

Table 2. Proportion of Ties Within and Between Schools

	Auburn Park		Twin Rivers	
	Proportion Within	Proportion Between	Proportion Within	Proportion Between
Literacy				
Overall	0.88	0.12	0.95	0.05
Minimum	0.82	0.06	0.88	0.00
Maximum	0.94	0.18	1.00	0.12
Math				
Overall	0.88	0.12	0.92	0.08
Minimum	0.73	0.00	0.83	0.00
Maximum	1.00	0.27	1.00	0.17

Below, we report findings from our analyses in three stages. We begin by modeling those factors that are associated with the occurrence of a tie between two school staff members *both within and between* schools. Next, using our interview data we explore school leaders and teachers reasoning about their 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.

Modeling Intra- and Inter-School Instructional Ties in Local School Systems

Using the covariate 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. To aid interpretation of statistical significance of each covariate in the models, quantiles from the distributions of estimation samples are reported alongside each parameter estimate. 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 zero, the estimate will be statistically significant at the 5% level. As we present our findings, we focus on results from Auburn Park and refer to Twin Rivers only when patterns differ.

Intra-School 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. 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 (2.96) and mathematics (3.34). Conversely, the small negative dyadic effect of same gender for both language arts (-0.22) and mathematics (-0.51) indicates that being of the same gender slightly decreased the odds of having an instructional advice and information tie. Regarding individual-level factors, one's career stage also had a negative effect in language arts (seeker effect: -0.36, provider effect: -0.21) and mathematics (-0.41, -0.25), suggesting that professionals in later career stages were less likely to either provide or seek content-related advice. Similarly, 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 (-2.06, -2.04) and mathematics (-2.64, -2.69) in Auburn Park (see Tables 3 and 4). Overall, 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 career stage.

Turning our attention to another aspect of the formal organization, we find that having a formal leadership position, and a subject-specific leadership position in particular, also increased the odds of a school staff member being sought out for instructional advice and information within their schools. While school staff members with formally-designated leadership positions were more likely to provide advice and information than individuals without such designations, we find 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 (4.31) was greater than the effect of being a non-subject specific leader (0.33) in Auburn Park language arts networks, and the effect of being a math leader (1.76) was greater than being a non-subject specific leader (0.43) in the district's math networks. We found a similar pattern in Twin Rivers in language arts, but not in mathematics.

This difference between school districts in the extent to which mathematics formal leaders provided advice and information can be attributed, at least in part, to differences in how these leadership positions were structured. In Auburn Park, there were four full-time mathematics coaches who spent time at multiple schools, and there were an additional seven classroom teachers who had math specialist designations. In Twin Rivers, there was only one mathematics coach who served eight of the district's schools, and five classroom teachers who served as mathematics specialists.

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 (-0.35, -0.26) whereas this covariate was not significant in Twin Rivers. Similarly, subject-specific leaders in both districts were not more or less likely to seek out instructional advice or information. Given that subject-specific leaders and other formal leaders are considered experts and could be expected to 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 school organizational structure in influencing instructional advice and information seeking patterns *within* schools.

Inter-School Advice and Information Interactions

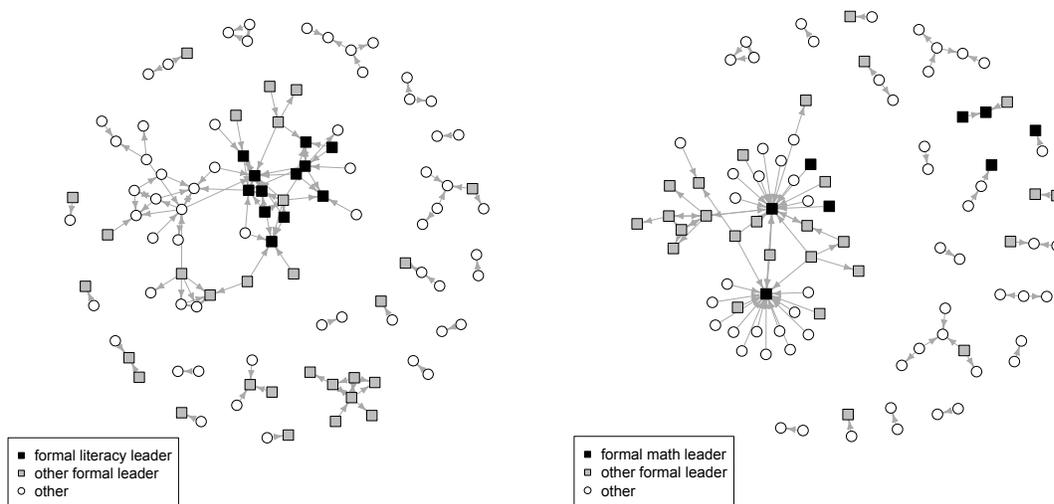
Between schools, we similarly found that the formal organization superseded individual characteristics in forging ties, and that formal leadership, more than anything else, predicted instructional advice and information ties. The main difference in within- and between-school findings was that formal leaders actively sought instructional advice and information across schools in addition to providing such information. In particular, being a subject-specific leader increased the likelihood of providing instructional advice and information to individuals in different schools; this effect was large in Auburn Park, 2.81 for language arts and 3.29 for mathematics, and similar in Twin Rivers. On the other hand, other formal leaders were slightly more likely to provide advice in language arts and mathematics in Twin Rivers, but results were less conclusive in Auburn Park. With respect to advice seeking, we found that subject-specific leaders were much more likely to seek advice across schools in Auburn Park (language arts: 2.48, math: 1.29), although this result was significant in Twin Rivers only for language arts leaders

(2.44). Similarly, other formal leaders were more likely to seek advice in both language arts and mathematics in Auburn Park (0.63, 0.76), but not in Twin Rivers.

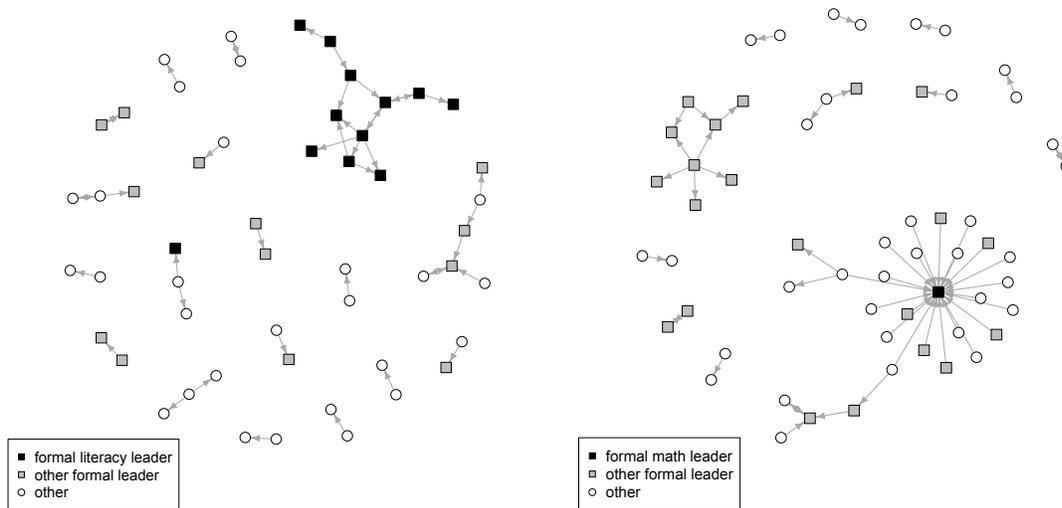
A descriptive analysis of our survey data illuminates the centrality of formal leaders in inter-school advice and information ties (see Figure 1). Figure 1, displaying only *between-school* ties, captures several patterns that persist across school subjects and the two districts. First, subject-specific leaders (black squares) tended to be well-connected in between schools, providing advice to large numbers of teachers and formal leaders at other schools. Second, non-subject-specific leaders (gray squares) in general were disproportionately represented in between-school networks, suggesting that these other formal leaders were especially important in facilitating between school instructional interactions. Still, Figure 1 suggests that teachers with no formal leadership positions (white circles) are an important in between school interactions about instruction though they tended to occupy less central positions in the networks.

Figure 1. Between-School Advice and Information Brokers

Auburn Park



Twin Rivers



With respect to other aspects of the formal organization, we included the organizational covariate *array* in our analysis of between-school ties in Auburn Park, finding that being in the same array slightly increased the likelihood of between-school ties in language arts, but slightly decreased the likelihood of between-school ties in mathematics. Being in the same array provides formal opportunities for teachers to interact among themselves and subject-specific leaders. In language arts, this grouping promoted interactions across schools whereas in mathematics, we suspect that this structure instead facilitated interaction with the math leaders, rather than inhibiting ties among teachers. Figure 1 supports this belief since the math leaders provide across school advice to many more teachers than the language arts leaders. School staff members in Auburn Park were more likely to form an advice or information tie with someone 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 found little evidence that career stage greatly affected advice providing or seeking between schools. For example, there was a very small positive effect of career stage for providing advice in mathematics in Auburn Park,

and small negative effects on mathematics advice providing and language arts advice seeking in Twin Rivers.

Table 3. Covariate Blockmodels for Within and Between School Ties, Language Arts

	Auburn Park (n=389)				Twin Rivers (n=320)			
	Parameter		Quantiles		Parameter		Quantiles	
	Est.	(S.E.)	2.5	97.5	Est.	(S.E.)	2.5	97.5
Within Block								
<i>Dyadic level (Level 1)</i>								
Same grade	2.96	0.11	2.76	3.16	2.07	0.10	1.89	2.28
Same sex	-0.22	0.08	-0.37	-0.06	-0.39	0.09	-0.56	-0.21
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
Multiple grades	-2.06	0.11	-2.28	-1.81	-1.47	0.11	-1.67	-1.25
Career stage	-0.36	0.02	-0.41	-0.32	-0.24	0.03	-0.29	-0.19
Formal leader	-0.35	0.10	-0.53	-0.16	-0.02	-0.10	-0.21	0.16
Language arts leader	0.45	0.26	-0.06	0.93	-0.06	0.23	-0.52	0.42
<u>Provider Level</u>								
Multiple grades	-2.04	0.12	-2.26	-1.81	-1.65	0.11	-1.87	-1.45
Career stage	-0.21	0.03	-0.26	-0.15	-0.16	0.03	-0.21	-0.11
Formal leader	0.33	0.10	0.14	0.52	0.53	0.10	0.35	0.72
Language arts leader	4.31	0.15	4.01	4.61	2.29	0.15	2.01	2.58
Between Block								
<i>Dyadic level (Level 1)</i>								
Same grade	0.71	0.22	0.30	1.14	0.32	0.35	-0.29	1.01
Same sex	-0.24	0.18	-0.56	0.11	-0.22	0.32	-0.85	0.41
Array	0.36	0.19	0.02	0.75	--	--	--	--
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
Multiple grades	-0.24	0.22	-0.62	0.17	-0.07	0.33	-0.74	-0.55
Career stage	-0.23	0.06	-0.34	-0.11	-0.43	0.10	-0.64	-0.23
Formal leader	0.63	0.20	0.26	1.00	-0.10	0.41	-0.93	0.71
Language arts leader	2.48	0.25	2.01	3.01	2.44	0.35	1.75	3.11
<u>Provider Level</u>								
Multiple grades	-0.07	0.20	-0.44	0.35	0.02	0.35	-0.72	-0.67
Career stage	-0.03	0.06	-0.15	0.08	-0.08	0.10	-0.28	-0.11
Formal leader	0.31	0.22	-0.10	0.72	0.69	0.34	0.07	1.37
Language arts leader	2.81	0.23	2.30	3.24	2.50	0.35	1.80	3.16

Table 4. Covariate Blockmodels for Within and Between School Ties, Mathematics

	Auburn Park (n=389)				Twin Rivers (n=320)			
	Parameter		Quantiles		Parameter		Quantiles	
	Est.	(S.E.)	2.5	97.5	Est.	(S.E.)	2.5	97.5
Within Block								
<i>Dyadic level (Level 1)</i>								
Same grade	3.34	0.11	3.14	3.57	2.51	0.12	2.27	2.74
Same gender	-0.51	0.09	-0.69	-0.33	-0.54	0.10	-0.73	-0.34
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
Multiple grades	-2.64	0.13	-2.91	-2.39	-2.42	0.14	-2.68	-2.16
Career stage	-0.41	0.03	-0.47	-0.35	-0.31	0.03	-0.37	-0.25
Formal leader	-0.26	0.13	-0.51	-0.02	0.17	0.11	-0.04	0.39
Math leader	-0.09	0.29	-0.75	0.45	0.17	0.29	-0.39	0.77
<u>Provider Level</u>								
Multiple grades	-2.69	0.12	-2.93	-2.46	-2.49	0.14	-2.75	-2.25
Career stage	-0.25	0.03	-0.31	-0.20	-0.20	0.03	-0.26	-0.15
Formal leader	0.43	0.12	0.18	0.64	0.87	0.10	0.67	1.05
Math leader	1.76	0.18	1.42	2.13	-0.47	0.27	-0.99	1.48
Between Block								
<i>Dyadic level (Level 1)</i>								
Same array	-0.55	0.28	-1.15	-0.02	--	--	--	--
Same grade	0.74	0.23	0.30	1.21	-0.51	0.34	-1.28	0.15
Same sex	-0.49	0.20	-0.86	-0.11	-0.47	0.27	-0.99	0.06
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
Multiple grades	-1.95	0.41	-2.86	-1.22	-0.26	0.34	-0.89	0.40
Career stage	-0.26	0.07	-0.39	-0.14	-0.26	0.09	-0.43	-0.09
Formal leader	0.76	0.21	0.37	1.16	0.51	0.28	-0.01	1.01
Math leader	1.29	0.39	0.49	1.94	-0.61	0.80	-2.32	0.74
<u>Provider Level</u>								
Multiple grades	-2.16	0.38	-2.88	-1.43	0.03	0.35	-0.71	0.71
Career stage	0.15	0.06	0.04	0.26	0.05	0.08	-0.10	0.20
Formal leader	0.50	0.25	0.00	0.97	0.70	0.32	0.10	1.29
Math leader	3.29	0.21	2.88	3.72	3.40	0.31	2.77	3.98

Intra and Inter School Ties, Expertise and the Formal Organizational Infrastructure

The analysis reported above points to the importance of the formal school and school district organizational infrastructure in facilitating inter- and intra- school advice and information

interactions. Below we use our interview data in Auburn Park to explore school leaders' and teachers' reasoning about their instructional advice and information interactions. Our analysis both supports and extends the findings above by showing how aspects of the formal organizational infrastructure worked in tandem to shape instructional interactions.

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, 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, explained with respect to her colleague John, “He’s kind of become kind of 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 34 school leaders and teachers interviewed, 97% of them reported that expertise was a key consideration in seeking someone out for instructional advice. Further, thirty of these 34 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 offered other rationales *in addition to* expertise 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.

Expertise, Formal Position and Other Aspects of the Organizational Infrastructure

Formal leadership position, however, did not work in isolation to facilitate intra- and inter-school instructional interactions. Based on our analysis of interview data, we argue that formal position 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 toolbox and array routines. 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 both within and between schools. At the school level, the grade-level PLC routine facilitated intra-school interactions among staff. Rachel, a kindergarten teacher at Chamberlain, remarked with respect to the PLC routine, "our [grade] team plans and we get to collaborate together ... our math coach [Mary] ... 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 teacher at Kingsley also pointed out how, in the PLC routine, "we do plan every week as a [grade level] 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, while 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 mathematics.

Thirty-three of the 34 interviewees identified participation in these same *school-level* organizational routines 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 - the 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 teaching the same grade level and provide common artifacts around which teachers can interact such as student achievement data and textbooks. As might be expected, 21 interviewees identified physical proximity as a reason for interacting with a colleague about instruction.

Second, school staff perceived a colleagues' participation in *district-level* organizational routines as signaling both their expertise in, and access to information about, instruction. Katie a sixth 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 [district] toolbox [routine] 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 colleagues' participation in the district level toolbox or array routines signaled their expertise in a content area and a reason for seeking them out for instructional advice and information.

Moreover, district-wide routines provided school staff with access to the advice and information of colleagues and subject-specific leaders at other schools. Laura, a third teacher at Kingsley Elementary, explained “we have array meetings and 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 went on to say that participation in the district's 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.” Similarly, Joanne a sixth grade teacher at Bryant noted how she “talked to other members of the math toolbox, Barbara is on the math toolbox ... And so I’ve talked to Pam and Alex outside the building, about math and they are also on the district [math] toolbox.” District-level routines both signaled expertise in a particular instructional area and afforded opportunities for school staff members at different schools to interact with these experts.

Third, organizational routines also 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. 100% of the school staff members we interviewed suggested that a shared professional experience due to participation in the same organizational routine was a key reason 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 goes 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, offered a similar explanation, pointing out that she interacts 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 ... 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 math toolbox that's how I came connected with her then. 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 continues to influence their interactions with one another about mathematics.

School Characteristics and Instructional Ties that Span Schools

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 and we examine the characteristics of schools that predict ties between two school buildings. To do so, we collapsed individual school staff members' ties to capture school-to-school connections. That is, if teacher A at school X was connected to both teacher B and C at school Y, those two ties counted as just one tie between schools X and Y. Moreover, we only examined ties between schools that occurred at least monthly.

The models in Tables 5 and 6 show the likelihood of advice and information ties between two schools in the same district as a function of school-level measures and dyadic-level measures determined by school similarities.¹ Here, schools that were more similar in terms of their percentages of students receiving free and reduced-price lunches were more likely to have at least one monthly tie related to language arts, as reflected in the negative dyadic-level effect of

¹ The major difference in these models compared to the earlier block models is that school organizations rather than individual teachers or school leaders are the nodes.

free and reduced lunch dissimilarity in both Auburn Park (-0.07) and Twin Rivers (-0.08). The same pattern was evident in mathematics in Twin Rivers (-0.08), but was not significant in Auburn Park (-0.03). In terms of advice seeking, schools in Auburn Park with higher average percent proficiency on the state mathematics test were less likely to seek mathematics advice from other schools at least monthly, as reflected in the negative seeker effect of percent proficient (-0.14) in Table 5. We did not find similarly significant results for language arts or in Twin Rivers. Overall, these findings suggest that schools with similar student populations tended to share instructional advice and information and that higher-performing schools tended to “keep to themselves,” and were less likely to seek external advice or information than lower-performing schools, especially in Auburn Park with respect to mathematics instruction.

Table 5. p2 Models for at Least Monthly Between-School Ties, Auburn Park

	Language Arts (n=14)				Mathematics (n=14)			
	Parameter		Quantiles		Parameter		Quantiles	
	Est.	(S.E.)	2.5	97.5	Est.	(S.E.)	2.5	97.5
Seeker Variance	1.68	1.26	0.29	4.98	0.73	0.77	0.08	2.86
Provider Variance	1.27	0.98	0.21	3.76	1.52	1.32	0.16	5.00
Covariance	1.24	0.99	0.13	3.79	0.17	0.81	-1.37	2.04
Density	1.43	6.20	-10.51	13.92	0.68	5.65	-9.50	12.52
Reciprocity	1.16	0.72	-0.28	2.49	1.17	1.11	-0.93	3.32
<i>Dyadic level (Level 1)</i>								
Free and reduced-lunch dissimilarity	-0.07	0.02	-0.12	-0.02	-0.03	0.02	-0.07	0.01
Size dissimilarity	-0.00	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.00
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
% Proficient	-0.08	0.07	-0.22	0.06	-0.14	0.05	-0.24	-0.05
Teacher-teacher trust	1.21	1.37	-1.54	3.79	2.11	1.42	-0.81	4.91
Deviance	132.4				90.2			
Bayesian information criterion (BIC)	309.3				267.2			
Newton-Raftery p4	-82.8				-59.7			
Log-likelihood	-75.8	4.1			-53.7	4.0		

Table 6. p2 Models for At Least Monthly Between-School Ties, Twin Rivers

	Language Arts (n=14)				Mathematics (n=14)			
	Parameter		Quantiles		Parameter		Quantiles	
	Est.	(S.E.)	2.5	97.5	Est.	(S.E.)	2.5	97.5
Seeker Variance	2.64	3.62	0.14	12.55	6.86	10.67	0.23	38.07
Provider Variance	0.40	0.39	0.06	1.50	0.87	1.16	0.07	4.32
Covariance	0.15	0.91	-1.51	2.22	-1.13	3.20	-10.41	2.28
Density	-5.49	6.86	-20.0	7.7	4.03	6.56	-8.59	18.00
Reciprocity	1.77	1.44	-1.13	4.50	2.72	2.04	-0.73	7.38
<i>Dyadic level (Level 1)</i>								
Free and reduced-lunch dissimilarity	-0.08	0.04	-0.16	-0.02	-0.08	0.03	-0.15	-0.02
Size dissimilarity	-0.00	0.01	-0.02	0.01	-0.00	0.01	-0.01	0.01
<i>Individual level (Level 2)</i>								
<u>Seeker Level</u>								
% Proficient	-0.02	0.05	-0.11	0.08	-0.02	0.05	-0.13	0.09
Teacher-teacher trust	1.19	1.70	-2.31	4.60	-1.41	1.62	-4.93	1.60
Deviance	53.0				46.0			
Bayesian information criterion (BIC)	229.9				222.9			
Newton-Raftery p4	-36.9				-35.8			
Log-likelihood	-32.0	3.6			-29.6	4.1		

Discussion and Conclusion

Scholars and policymakers recognize the importance of school organizations and education systems that enable practitioner learning on the job 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, materials, and so on that can enable instructional improvement in schools. Recognizing the scarcity of empirical knowledge on those factors associated with the presence of social ties as well as the limited attention to ties that go beyond the particular school, we explored factors associated with instructional advice and information ties both *within* schools and *between* schools.

Consistent with some prior work (Small, 2009; Spillane et al., 2012), our analysis suggests that while the individual characteristics of gender and career stage of school staff are associated with the presence of instructional advice and information ties *within schools*, aspects of the formal organization are much more strongly associated with such ties. Specifically, the formal organization in terms of teaching assignment (i.e., same grade assignment *and* multiple versus single grade assignment) and holding a formal leadership position has a stronger relationship with the presence of a tie in both mathematics and language arts among staff *within schools*. Similarly, with respect to *between schools* our analysis suggests that aspects of the formal organization (i.e., formal leadership position, same grade assignment) superseded individual characteristics in forging instructional advice and information ties: Having a formal leadership position predicted instructional advice and information ties about mathematics and language arts instruction more than anything else with formal leaders more likely to both seek and provide instructional advice and information between schools. And, 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' advice and information ties about teaching. Based on our analysis of interview data, we argued that school staff associated leadership positions and the specialized training that came with these position with having expertise about instruction. Scholars use the construct of "transactive memory" to refer to peoples' use of knowledge encoded *externally* (e.g., in formal positions) to access expertise (Moreland & Argote, 2003; Wegner, 1986, 1995). Transactive memory is fundamentally about knowing who knows what in an organization or system. By creating formal

positions as well as investing in formal training, school systems can shape the transactive memory of their staff.² In much the same way, district level organizational routines influencing transactive memory by signaling that those who participated in these routines had particular expertise and access to information.

Our analysis also shows that characteristics of the student population of a school appears to matter when it comes to ties between schools: Schools with similar proportions of students from the same socioeconomic background were more likely to have ties to one another, 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, as lower-performing schools tend to have more disadvantaged student populations and are more likely receive Title 1 funds, it is possible that there is more pressure on and opportunities for these schools (from local, state, and federal policies) to reach out for advice and information to other schools.

Finally, as we noted throughout this paper, social ties are a necessary but not sufficient condition for social capital development, so future research will need to differentiate between intra- and inter- school advice and information ties that do and don't contribute to the development of new instructional knowledge and in turn changes in instructional productivity as measured by gains in student learning outcomes. Using longitudinal social network data, scholars can not only identify 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

² There is empirical evidence to suggest that performance is higher in groups where members are aware of who knows what information (Wegner, Erber, & Raymond, 1991; Wegner, 1995; Hollingshead, 1998).

outcomes. Doing so will enable us to differentiate between instructional ties that teach and those that don't.

Our analysis does offer some guidance for educational policymakers and administrators interested in developing social capital. One lesson is that formal organizational structures do matter and matter more than individual characteristics of race and gender when it comes to advice and information ties among elementary school staff about teaching mathematics and language arts. Considering that formal leaders in general, especially subject-specific formal leaders, are more likely to provide instructional advice or information, then administrators should exercise care in selecting individuals considering their central role in the social networks both at the school and system level. Selecting individuals not only with a deep knowledge of instruction but also individuals whose instructional beliefs and expertise is 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 weight decisions about teaching assignments carefully considering that same grade is strong associated with tie formation and that teachers who teach multiple grades are less likely to provide or seek advice in schools. Decisions about teaching assignments are often based on assigning teachers to grades based on their experience or ability working with a particular age group (e.g., primary versus senior grades) and/or ensuring that teachers work in grades with colleagues with whom they get along. But, if our analysis is roughly right then administrators should also take into account the instructional expertise of teachers in assigning them to particular grades in that ensuring that more 'expert' teachers are distributed 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 re-assigning 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 that there are trade-offs here in that administrators have also to take into account the fact that some teachers are more effective with particular grades – early versus later elementary grades and indeed that moving to a different grade increases a teacher’s preparation time. Our analysis of interview data also suggests that while physical proximity and responsibility for similar curricular material help 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 – were especially prominent in school staff members’ reasoning about their instructional advice and information interactions.

Finally, district-level administrators working toward districtwide 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 y 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 in this paper, 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 the 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 school or classroom practice.

Additionally, we also note a limitation inherent to statistical models for inference: it is possible that unobserved or unmeasured factors influence patterns of instructional advice and information interactions. Finally, our analysis is limited with respect to generalizability because we rely on data from two school districts in the same state though 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.

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