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Of Teams and Ties: Examining the Relationship Between Formal and Informal Instructional Support Networks

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Abstract

Purpose: This study examined an urban district's capacity to diffuse instructional innovations. Social network analysis (SNA) was used to examine the relationship between "informal" teacher support networks and "formal" teacher support networks engineered by administrators through required membership on a team. This study also sought to uncover how school leaders considered study findings in light of their district's theory of change to improve teacher collaboration. **Method:** About 1,100 employees responded to a sociometric survey that queried for demographics, team membership, and advice-seeking behavior. SNA methods were used to examine network cohesion (i.e., size, density, isolates, ties) and degree centrality. Statistical analyses (chi-square and multinomial logistic regressions) were performed to examine how team membership were associated with teachers' advice-seeking behaviors. Visual inspection of sociograms was used to communicate and make meaning of findings with district personnel. **Findings:** The majority of teachers' informal instructional support ties were concomitant with shared membership on an administrator created formal

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team. The majority of teachers who reported that at least one colleague had a strong, positive influence on their practice, also participated in at least one formal team, and believed their team's collaboration positively affected their instructional practice. **Implications:** School leaders affect quality of instructional support networks through organizational design. The extent to which teachers are able to access social capital and instructional support is influenced by the choices administrators make about how to structure teacher collaboration.

Keywords
social network analysis, social capital, teacher collaboration, organizational design, instructional support

Introduction

> Teachers' professional development is largely a product of formal and informal social interactions among the teachers, situated in the context of their school and the classrooms in which they teach and distributed across the entire staff. If implemented and supported effectively, [these interactions] have the potential to contribute to the development of all teachers within a team or school by generating conversations among teachers about concrete acts of teaching and student learning. (Croft, Coggshall, Dolan, Powers, and Killion, 2010, p. 5)

Teacher collaboration is nothing short of a modern educational zeitgeist. For at least two decades, appeals for teachers to work together to improve their practice and examine student progress have continued to come from the policy arena, educational research, and from teachers themselves. The significance of teacher collaboration for building instructional capacity and student achievement has been suggested by many educational reform studies and embraced by educational policy makers around the world (Gable & Manning, 1997; Moolenaar, Sleegers, & Daly, 2012). When teachers work together, the benefits can be numerous. Improved job satisfaction and teacher retention (Johnson, Kraft, & Papay, 2012), school climate (Skaalvik & Skaalvik, 2011), and student achievement scores (Egodawatte, McDougall, & Stoilescu, 2011; Garet, Porter, Desimone, Birman, & Yoon, 2001; Lomos, Hofman, & Bosker, 2011) are all frequently cited as returns on the investment of high-quality collaboration.

Yet the pitfalls may be as thorny as the promises are rosy. Historically, teachers have been expected to operate in relative professional isolation, and this norm is not easily reset. Unlike MBA programs, which often focus heavily on the theory and practice of teaming and interpersonal work dynamics,

most teacher preparation programs never touch on (or merely skim the surface of) how to collaborate. And since most school leaders are drawn from the ranks of the instructional force, they, too, are often at a loss, both conceptually and practically, for how to uphold standards of professional practice charging them to enact systems of teacher collaboration (National Policy Board for Educational Administration, 2015). Leaders frequently worry about the logistics of how to establish conditions for collaboration (concerns of time and space are often paramount) and about how to skillfully facilitate professional interactions (Dufour, Dufour, & Eaker, 2008; McLaughlin & Talbert, 2006). Furthermore, the idea that collaboration should ideally be "organic" is one that frequently comes up in conversations with teachers and school leaders about why, as a school-sponsored initiative, collaboration may be more of an intrusion than an innovation (Johnson, 2003).

Debate persists among theorists and practitioners about the value of informal teacher ties versus formal educator collaboration (Penuel, Riel, Krause, & Frank, 2009). Recent research shines a light on the importance of informal teacher networks, that is, the predictors and benefits of social connections between teachers (e.g., power, influence, friendships, etc.) that have formed without a "network intervention" (Van Waes, De Maeyer, Moolenaar, Van Petegem, & Van den Bossche, 2018). Informal ties that form voluntarily between teachers have been found to dissolve at high rates each year and do not tend to re-form (Spillane & Shirrell, 2017). Few studies have explored if and how effective *nonvoluntary* support networks form. School leaders would benefit from research that sheds light on the concrete network interventions they could enact to establish strong, supportive, and sustainable teacher instructional support networks that are less vulnerable to the churn of voluntary and organically formed ties between teachers.

The central aim of this study was to use social network analysis (SNA) to examine how an urban district's formal instructional support networks (teacher support networks constructed by principals) relate to the district's voluntary instructional support networks (natural advice-seeking ties), and how such networks enable teacher access to social capital resources embedded within those networks. A secondary aim of the study was to describe how school leaders interpreted and used SNA findings to inform their theory of action and plan for future school reform and improvement efforts.

Our study is situated at the nexus of two emergent streams of educational research: Studies that explore teacher access to social capital resources through informal peer collaboration (e.g., Fox & Wilson, 2015; Penuel, Sun, Frank, & Gallagher, 2012; Whitcomb, Woodland, & Barry, 2017), and scholarship that examines the role of school leaders in the development and sustainability of social capital in schools (e.g. Bryk, Sebring, Allensworth,

Easton, & Luppescu, 2010; Deal, Purinton, & Waetjen, 2009; Tschannen-Moran & Gareis, 2015).

Study Context and Setting

This study was one of three substudies within a larger project designed to help examine and develop an urban district's capacity to diffuse computer science curricula and high-quality instruction throughout their K-12 classrooms. The district served more than 25,000 students from preschool to Grade 12 in 32 elementary schools, 12 middle schools, 3 schools serving Grades 6 to 12, and 8 alternative schools. The district also included magnet schools, vocational schools, and a variety of other specialized educational settings. During the 2015 to 2016 school year, nearly 20% of the district's students were African American, 65% were Hispanic, 12% were White, and 3% were Asian. More than 67% of the district's children were classified as economically disadvantaged (among the highest in the state), and more than 26% did not speak English as a first language. Nearly 20% of the district's students were classified as having disabilities, and 78% were considered "high needs." There were roughly 2,040 teachers in the district. Overall, the district was rated by its state as one in need of substantial assistance.

In the several years prior to this study, the district leadership team had focused increasingly on establishing structures for teacher collaboration and job-embedded professional development. At the time the study was initiated, all teachers had been assigned by administrators to at least one professional learning community (PLC) that was focused on improving classroom instruction. School leaders had created time and expected every PLC to meet regularly for at least 90 minutes during the district's extended days once every week.

The district's theory of action. A theory of action, often depicted as a logic model (Torres, 2005), can reveal underlying assumptions held by administrators about the mechanisms they believe will bring about change in their schools. Theories of action are effectively stories of why problems exist and what can be done to address them (Weiss, 1995). There is value in having a theory of action to guide school change (City, Elmore, Fiarman, & Teitel, 2009; Fullan, 2006); theories of action can help surface tacit understandings about how immediate actions and activities lead to intermediate goals, and how the attainment of intermediate goals will ultimately lead to essential organizational outcomes (Argyris & Schon, 1974). It is expected that theories of action will necessarily evolve and deepen through the reflection process (City et al., 2009). As part of the current project, district administrators developed a logic model to explicate their theory of action, that is how their

Table 1. District Professional Learning Community (PLC) Theory of Action.

Inputs	Activities	Outputs	Short-Term Outcomes	Long-Term Outcomes
Provide PLC meeting space Create PLCs of 3 to 5 members Assign *all* teachers to at least one PLC Curriculum frameworks	PLCs collaborate 90 minutes per week PLCs design curriculum PLCs look at their instructional practices PLCs look at student work	All teachers have access to strong, positive professional support All teachers increase their knowledge and skills	Instructional practice continuously improves/is responsive to student learning needs All students are engaged in their classroom learning environment	All students demonstrate high levels of authentic achievement and meaningful learning

primary school reform strategy (the enactment of PLCs) was intended to lead to their most essential organizational outcome—equitable, meaningful student learning (see Table 1).

Substantive school improvement may be more likely to occur when school leaders revisit and test their theories of action against evidence of achievement and progress. As will be discussed later in this article, district administrators considered findings of this study in light of their logic model and collective understanding of how PLCs lead to student learning.

Framing the Work

This study is predicated on two related bodies of literature: social capital theory and research on organizational design in schools. Social capital refers to the actual or potential resources that lie in relationships or connections between people, rather than in people themselves (Bordieu, 1986; Lin, 1999, 2001). Such resources typically fall into one of four broad categories: information, influence, social credentials (a reflection of persons' access to resources outside themselves), and reinforcement of belonging and identity (Lin, 2001). Organizational design—the conditions in which teachers and students operate—is considered to be a primary responsibility of and powerful tool for schools' leaders (Leithwood, Harris, & Hopkins, 2008).

Social capital theory. Social capital refers broadly to the idea that individuals are embedded in social structures, that relational ties between individuals in

those structures serve as conduits for the exchange of resources, and that such resources can be accessed to advance individual or institutional goals (Nahapiet & Ghoshal, 1998). It is understood that rather than being located *in* individual actors, social capital is located in the ties *between* actors (Coleman, 1988). Collegial relationships within schools are teachers' primary source of social capital (Cross & Sproull, 2004).

Social capital can be thought of as "an investment in social relations by individuals through which they gain access to embedded resources to enhance expected returns of *instrumental* or *expressive* actions" (Lin, 1999, p. 39). Instrumental networks are characterized by relationships that can be used to service organizational goals; for example, work-related advice-seeking and information sharing (Cole & Weinbaum, 2010; Lin, 1999). By comparison, expressive relationships serve more affective ends—expressive ties transmit resources of friendship, social support, and trust, among others. Naturally, such expressive ties tend to be stronger and more resilient than instrumental ones (Granovetter, 1973; Ibarra, 1993).

In schools, a large body of literature supports the idea that when teachers are connected to each other in an instrumental way, they are able to substantially influence the quality of each other's work in a variety of ways. The effectiveness of a teacher's immediate grade level colleagues, for example, positively effects the test scores of that teacher's students (Jackson & Bruegmann, 2009). The introduction of an effective new peer into an existing teacher group has significant positive effects the test scores of the rest of the group (Sun, Loeb, & Grissom, 2017). It is known that instructional expertise can be transferred, or travel, through professional interactions (Penuel, Frank, Sun, Kim, & Singleton, 2013); that the existence of ties may provide the impetus for teachers to make their knowledge explicit, thus making it more accessible to colleagues (Eraut, 2000); and that ties between teachers enable access to resources of advice and information that can support knowledge development (Coburn, 2001; Daly & Finnigan, 2010; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Spillane, 2004). Overall, a robust and growing body of literature supports the idea that teachers' access to social capital resources has a key role to play in a broad array of school reforms (Bryk & Schneider, 2002; Frank, Zhao, & Borman, 2004; Garmston & Wellman, 1999; McLaughlin & Talbert, 2006; Rosenholtz, 1991). As can be seen in their theory of action/logic model, school leaders in this district believe they play a central role in creating organizational conditions for teacher access to social capital through the creation of PLCs.

Organizational design. Despite the importance of social capital to school improvement efforts, it is often challenging for school leaders to effectively

overcome norms of teacher isolation and establish the conditions that foster and sustain ties (Daly, 2010). Informal interactions that take place in teachers' lounges, mail rooms, and after-hours gathering spots are widely recognized as powerful transmissions of advice and information (Deal et al., 2009). Although a growing body of literature indicates that networks of *informal* relational ties between teachers exist and are important (Becker, 1999; Deal et al., 2009; Wesley & Franks, 1996), those voluntary, and more "naturally" occurring ties tend to lay outside of school leaders' immediate locus of control. The establishment of *formal* ties between teachers, however, falls directly within the purview of school leaders (Gajda & Koliba, 2007, 2008; Woodland, 2016). Indeed, thoughtful design of organizational conditions for teacher collaboration that enables access to social capital is considered a primary responsibility of school leaders (Chance & Segura, 2009; Daly & Finnigan, 2010; Leithwood et al., 2008; NBPEA, 2015; Sergiovanni, 1994; Woodland & Mazur, 2015a).

Numerous studies support the idea that school leaders can, by design, tailor organizational conditions to support the growth of teachers' social capital. Leana and Pil (2006) found that attending to the overall structure of a school's network could facilitate information sharing and exchange of knowledge among individuals. Moolenaar and Sleegers (2010), working in the Netherlands, found that teachers in "dense" instruction-focused teams perceived their working climate to be more innovative than teachers in schools where fewer such relational ties existed. They emphasized the importance of links that "nurture and stimulate the growth of a schoolwide innovation-supportive climate in which risk taking can occur in a safe environment" (p. 111). Coburn, Choi, and Mata (2010) looked at network structure in four U.S. elementary schools and found that relational ties can be heavily influenced by existing organizational norms, structures, and practices, and that "the tie formation process is amenable to policy intervention" (p. 48).

School leaders' role in teacher tie formation is multifaceted. School principals in particular are key to supporting teachers' tie formation through formal means, most notably by assigning teachers to leadership roles within the school (Spillane, Hopkins, & Sweet, 2015; Spillane, Kim, & Frank, 2012), assigning teachers to particular grade levels (Spillane & Shirrell, 2017), and by implementing and sustaining collaborative teaming structures (Coburn et al., 2010; Coburn & Russell, 2008). Numerous studies have supported the idea that collaborative teacher teams are important school-level factors for teacher learning (Jackson & Bruegmann, 2009; Moolenaar et al., 2012; Pounder, 1999; Ronfeldt, Owens Farmer, McQueen, & Grissom, 2015; Sun et al., 2017) though few have looked specifically at the extent to which formal teams may be directly related to teachers' "natural" and voluntary instrumental ties.

The primary focus of this study, then, was to look at the relationship between teachers' self-reported instrumental ties (those people from whom teachers report receiving strong positive support for instruction) and their formal instructional support networks (those people with whom teachers are tied to because they are assigned to administrator-arranged collaborative groups).

The three research questions that guided this study were:

Research Question 1: How does the structure of school-based formal instructional support networks compare to school-based voluntary instructional support networks?
Research Question 2: Does teacher membership on a formal, principal-constructed team enable access to strong, positive instructional support?
Research Question 3: How do district leaders plan to use the findings to inform their theory of action and future school reform and improvement efforts?

Research Methodology

This study's methodological approach is grounded in network theory and SNA. Network studies are increasingly used to help answer questions related to social capital in schools. Penuel et al. (2009) enumerate four main benefits of studying network structures among school faculty: The ability to articulate the structure of teacher community; the ability to analyze the composition of teacher subgroups; the ability to evaluate the success of initiatives aimed at improving collaboration; and the ability to investigate the ways in which peers transfer expertise and knowledge to each other. Network studies have also been used help examine schools' organizational capacity for professional learning (Daly, Moolenaar, Bolivar, & Burke, 2010; Farley-Ripple & Buttram, 2015; Moolenaar & Sleegers, 2010). SNA is a particularly useful approach for investigating questions of social capital and organizational design since, while the most basic incarnation of social capital exists in the connection between two people (dyads), a more complete picture of an organization's social capital can be achieved when all people (actors) in an organization are included. Also, because teams are one of the primary ways that school leaders support teachers' professional learning and their access to social capital, it is useful to get a bird's eye view on schools' teaming networks to allow for both visual inspection and quantitative analysis. Finally, a network approach is flexible enough to allow for a nuanced look at the relationships that exist in schools.

At base, SNA is a way of describing, measuring, analyzing, and visualizing relationships between actors in a social system. While often referred to as a method, SNA is in fact a "set of theories, models, and applications that are expressed in terms of relational concepts and processes" (Carolan, 2014, p. 4). SNA is, in some respects, a way of measuring a person's access to communal resources, as it assumes that "an actor's position in a network determines in part the constraints and opportunities that he or she will encounter" (Borgatti, Everett, & Johnson, 2013, p. 1). Moreover, it treats individuals in a network as independent actors, their behavior at least in part determined by the position they occupy in the network (Deal et al., 2009).

The foundation of social networks (and social network theory) is the idea that social ties of different types exist between actors. Typically, they are classified as one of four broad categories: similarities (e.g., having something in common, like group membership or gender), relations (e.g., friendship), interactions (e.g., sought advice) or flows (e.g., resource sharing) (Borgatti, Mehra, Brass, & Labianca, 2009). Network structure simply refers to the patterns of ties between a defined group of individuals. In education, SNA has often been used to help visualize and understand how resources and knowledge flow to and from educators in a school or district (Farley-Ripple & Buttram, 2015). Typically, network researchers look both at the overall characteristics of networks (generally referred to as measures of cohesion) and at the positions of nodes within a network (generally referred to as measures of centrality). Educational researchers often use these measures to investigate organizational factors such as social capital, capacity for reform, and organizational learning (Atteberry & Bryk, 2010; Daly & Finnigan, 2010; Daly et al., 2010). In this case, SNA allowed for the inspection of the interplay between formal and informal instructional support networks.

Data Collection Process

Data for this study were collected through a survey instrument that included items in three categories: demographic information, teaming information, and sociometric data.

Demographic information. Teachers were asked to indicate their gender, length of time served in district (seniority), and role in school (content-area or classroom teacher, computer science teacher, counselor, library media specialist, instructional technology specialist, other specialist teacher, instructional coach, administrator, etc.).

Teaming information. Teachers were asked to indicate whether they were a member of at least one formal (administrator assigned) team that focused on matters of instructional improvement. If the response was "yes," teachers were asked with what frequency and duration the team met, and the extent to which they believed the team had a strong positive influence on their instructional practice.

Sociometric data. To collect data about school-based instructional support networks, teachers were first asked to identify up to 10 close professional colleagues in their school. There are no generally accepted ways to phrase sociometric questions because the contexts in which they are asked vary widely. However, when collecting one-mode data (meaning people's relationships directly with each other) it is customary to use a variation of Moreno's (1953) basic sociometric test, which simply asks each actor in a network to identify the alters (others in the network) with whom the respondent has some relationship. It is then also typical for an instrument to immediately follow-up on that name generation with "interpreter questions" about the particulars of each relationship (Marsden, 2014). In this case, the limit of 10 alter nominations is based partly on a desire to limit the burden on respondents (White & Watkins, 2000) and also to bound responses to the strongest possible ties, since respondents tend to name closer ties sooner (Burt, 1986). Similar studies have constrained the number of responses to 5 (see Farley-Ripple & Buttram, 2015); however, it was determined that given the large number of teachers in some district schools, 10 was a more appropriate limit. In order to mitigate the possibility of imprecise responses (i.e., the use of nicknames), the survey items asked for both first and last names (Marsden, 2014).

For each person nominated by a respondent, two additional pieces of data were collected: strength of tie and shared team membership. These were asked in a "side by side" format—a respondent listed a name, then noted the frequency with which they interacted with each nominated person on a 5-point scale from *daily* to *yearly/none.* Then, they also indicated whether they were also on an instructionally focused team with each nominee. This design approach had the advantage of permitting the construction of networks that both included and excluded formal team-based ties between teachers. It enabled us to visualize the influence of team membership on teacher support networks. A possible limitation of this survey design, however, is that it does not construct two distinct networks, but rather conceptualizes each teacher's support structure as possibly including those with whom she or he shares team membership, and those with whom she or he does not.

Network analysis offers numerous measures of network structure; the ones most relevant for this investigation were instructional support network

size, ties, isolates, and *density. Size* is a notation of the number of actors in the network. In this case, actors are either classroom teachers (or other people with instructional responsibility such as librarians and reading specialists), principals, or instructional leadership specialists who were in place to serve mainly as math and literacy coaches. *Ties* indicates the number of connections that exist in the network. In a binary network, there is only one tie possible between Actor A and Actor B; any relationship is assumed to be reciprocal. In a directed network, however, there are two possible ties between Actors A and B—one directed from A to B, and one directed from B to A. Here, ties are reported based on the directed network. *Isolates* are reported to understand how many individual actors are disaffiliated with the network and thus without access to network resources.

Density refers to the actual proportion of ties that exist between people out of the total number of ties possible and can be used as an indicator of social cohesion (i.e., higher density = more cohesion). However, it cannot be assumed that a higher density score indicates a more effective communication network; a glut of ties may stymie the flow of information and resources just as surely as will a paucity of ties (Krackhardt, 1994). Typically, small networks are apt to have higher densities than large ones, given that it is easier to maintain ties with a small group of people than with a large one. Claims of social capital and its relation to density must be considered within the unique context of the network.

Network Analysis

Network analysts use different types of matrices depending on the type of data collected. In this case, one mode (or adjacency) matrices were called for, in which both *x* and *y* axes were populated with the identity codes of each respondent, and adjacent cells indicated the presence or lack of a tie. To construct matrices, the complete list of names at each school provided by the district was consulted first. The complete school roster was critical, because it allowed for ties to be established even to people who did not complete the survey. For example, because this study is about *teacher* support networks, principals were not surveyed. However, principals are often primary support-givers to teachers. Omitting principals because they were not survey participants, then, would substantially affect results and bias the data. The same principle held true for others who were nominated by respondents but did not participate in the survey themselves.

Because complete network data are often difficult to get, it is generally accepted that some level of missingness is tolerable (Rhodes & Keefe, 2007), and the general "rule of thumb" is that accurate networks can be constructed

with responses from between 70% to 80% of actors. For this study, the higher threshold was chosen, and only schools with at least an 80% response rate were included in the final sample.

Ultimately, six schools with the highest response rates were chosen for inclusion in this analysis. All were elementary schools serving children in kindergarten through Grade 5. Two matrices were constructed for each school. The first matrix captured the formal Instructional Support Network and included all reported relationships. The second set omitted any ties that were supported by shared membership on a formal instructional team (i.e., PLC, grade-level team, etc.). This was accomplished through a process of deletion, wherein all ties that existed in each network were checked against survey responses that indicated shared membership on a PLC. Those ties that were found to be supported by shared team membership were then deleted, and network matrices were imported into UCINET (Borgatti, Everett, & Freeman, 2002) and NetDraw (Borgatti, 2002) for analysis.

Information about district leaders' use of findings. This study was part of larger project that entailed regular research partnership meetings with district administrators. A district-wide group of teacher leaders, instructional coaches, principals, and central office administrators met three times with the research team to talk about the district's theory of action, the design of the research study, and study findings as they became available. To help district-based partners make sense of the data (especially network data, which are often unfamiliar to those who are inexperienced with SNA) researchers facilitated a series of protocols in which team members were asked, individually and in small groups, to consider the results in light of their theory of action/logic model. Written records from these partnership meeting were analyzed to gather data related to how district leaders planned to use the research findings in practice.

Findings

We organize the findings as follows: First, we summarize overall survey results, including who responded, the extent to which teachers have access to strong, positive instructional support, and with what frequency administrator assigned PLCs meet. For Research Questions 1 and 2, network measures of size, ties, isolates, and density are presented, as are side-by-side sociograms that visually contrast the structure of school-based formal instructional support networks to school-based voluntary instructional support networks. Last,

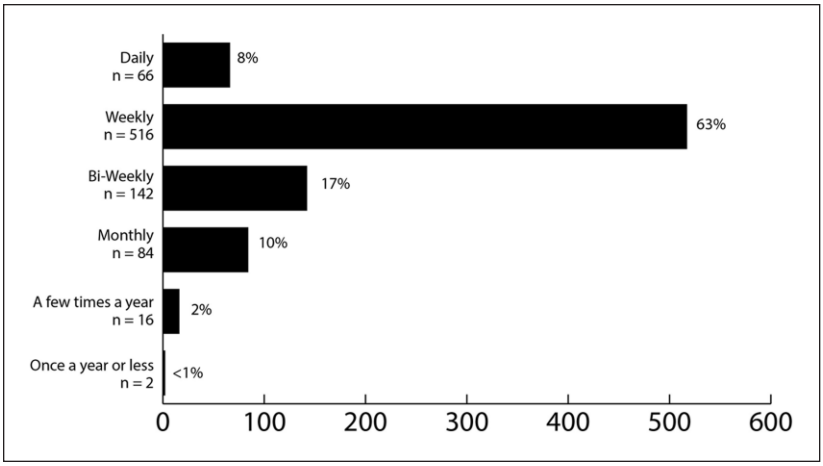


Figure 1. Reported frequency of team meetings.

we address Research Question 3 and explain how district leaders planned to use the findings to inform their theory of action and future school reform and improvement efforts.

Overall Survey Findings

The sociometric survey garnered 1,106 responses[1] from employees with instructional responsibility in the school district—including teachers, counselors, librarians, paraprofessionals, and others. Eighty-three percent of the respondents identified as female, and 17% identified as male. A majority of respondents (90%) indicated that there was at least one person in their school/district who had a strong positive influence on their teaching practice, while 10% of educators indicated that no other person in their school or district had a strong positive influence on their instructional practice. Overall, about 80% of respondents were a member of at least one team (e.g., PLC, data team, grade-level team) that met regularly and focused on matters of instruction. The majority of those instructional support teams met once a week (63%). Eight percent of teams met every day, 17% met every other week, and the remaining 10% met monthly or less than monthly each year. These results are shown in Figures 1 and 2, and Table 2.

The overwhelming majority of teachers felt that membership on a team had a positive impact on their teaching; more frequent team meetings were found to be significantly related to a teacher's perception that the team had a

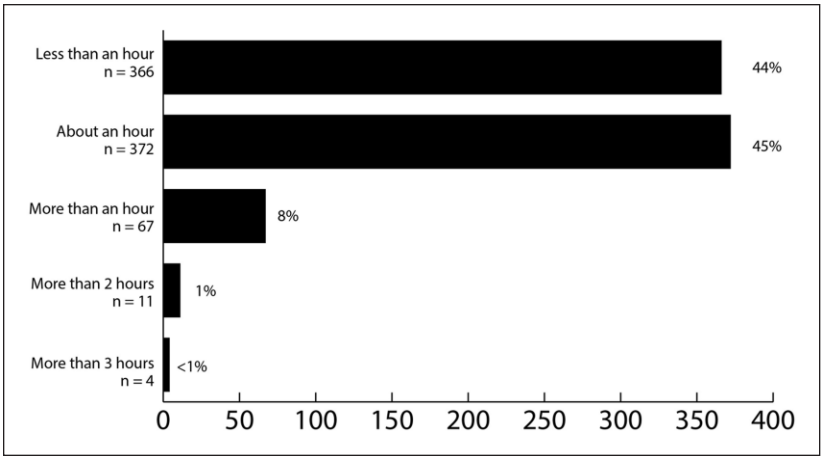


Figure 2. Reported duration of team meetings.

Table 2. Cross-Tabulation of Frequency of Team Meeting With Positive Impact on Practice.

	Daily	Weekly	Biweekly	Monthly	A Few Times a Year	Once a Year	Total
To what extent does the team have a positive impact on your teaching?							
No impact	0	7	2	1	2	0	12
Small impact	4	71	30	17	5	1	128
Moderate impact	19	217	70	38	6	0	350
Large impact	42	221	40	28	3	0	334
Total	65	516	142	84	16	1	824

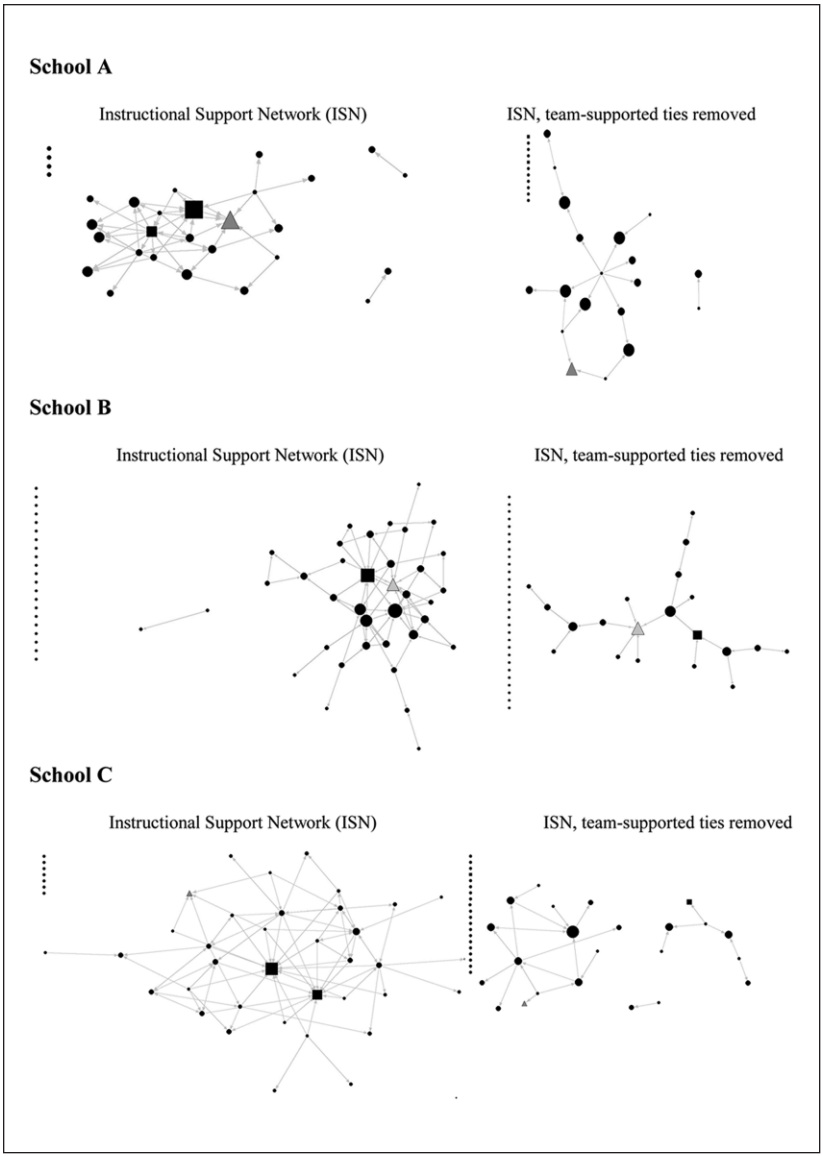
Note. $\chi^2 = 53.97$, degrees of freedom = 15. $p < .001$.

strong positive impact on the quality of their own instructional practice. Results are shown in Table 2.

Research Question 1

How does the structure of school-based formal instructional support networks compare to school-based voluntary instructional support networks? Sociometric survey responses were used to construct the networks. Sociograms, network measures, and descriptive statistics were used to analyze the data.

Results are depicted are in Figure 3. The formal, administrator-constructed teacher instructional support network for each school is shown in the


School A
Instructional Support Network (ISN)
ISN, team-supported ties removed
School B
Instructional Support Network (ISN)
ISN, team-supported ties removed
School C
Instructional Support Network (ISN)
ISN, team-supported ties removed

(continued)

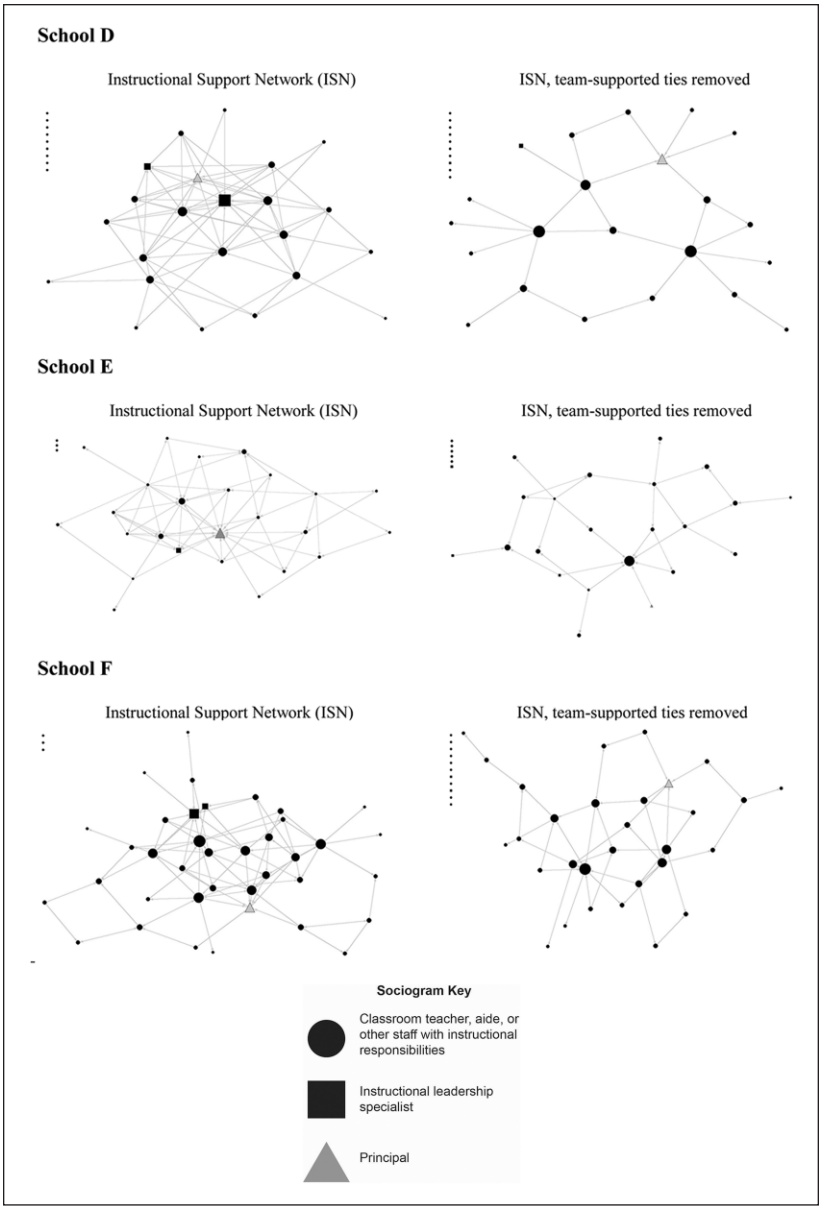


Figure 3. Sociograms for six elementary schools.
Note. Instructional support networks are shown on the left. Voluntary support networks (the same networks with team-supported ties removed) are shown on the right.

left-hand column for each of the six schools. In the right-hand column of Figure 3 are the voluntary instructional support networks that include only those relationship of instructional support that are not supported by shared membership on a team.

Nodes are shaped based on individuals' professional role (see sociogram key) and sized by in-degree (those with a higher in-degree—more people seek advice from them—are larger). Isolates, those teachers who do not seek support and that no one seeks advice from, are shown to the top left of each sociogram. No modifications were made to sociograms, so representations of geodesic distances (relative levels of connection between actors) are intact.

As illustrated in Figure 3 and Tables 3 and 4, roughly half (and in some cases more) of all informal instructional support-seeking relationships were related to the existence of shared membership on a formal administrator constructed instructional support teams (PLC). When team-supported ties were removed, as a rule, densities of the informal instructional support networks markedly decreased (average decline in density approached 60%; greatest decline was in School B) and the number of isolates markedly increased (average increase in isolates = 136%; greatest increase in School F). Though these associations do not indicate causality (it is unknown whether shared team membership directly forges, strengthens or sustains informal ties) the trend is notable because it visually demonstrates how teacher access to social capital (instrumental and expressive support from peers) appears to be mediated by shared membership on formal teams.

Without exception, the ISN at every school experienced a substantial decline in density and increase in isolates when conceptualized and constructed without team-supported ties. ISNs saw, on average, a 59% decrease in density. Importantly, these results suggest that nonvoluntary membership on administrator-created teams are critical components of the overall advice-seeking patterns of teachers. Teachers do have supportive informal relationships with other colleagues, but more than half of the "strong-positive" relationships are with those to whom teachers also have a formal administrator-generated organizational tie. Teachers who reported no or few supportive relationships were often not part of a formal team, or reported that their team had little affect on their classroom practice.

Research Question 2

Does teacher membership on a formal, principal-constructed team enable access to strong, positive instructional support? Results of a chi-square test of statistical significance supported what was revealed through the summary of survey data, visual inspection of the sociograms, and network analysis. Teacher

Table 3. Summary of Network Measures at Each School.

	Instructional Support Network (ISN)				ISN, Team Ties Removed			
	Size	Ties	Isolates	Density	Size	Ties	Isolates	Density
School A	30	48	4	.055	30	19	11	.022
School B	58	72	21	.041	58	19	38	.011
School C	43	87	7	.085	43	24	20	.025
School D	32	83	9	.145	32	26	10	.052
School E	28	67	3	.169	28	28	6	.074
School F	41	93	3	.101	41	48	11	.055

Table 4. Comparison of Decline in Density and Increase in Isolates When Team-Supported Ties Are Removed.

	School A	School B	School C	School D	School E	School F	Average
% decline in density	46	73	70	64	56	46	59
% increase in isolates	175	80	186	11	100	266	136

membership on an administrator assigned PLC was a positive predictor of strong supportive relationships between teachers. A statistically significant relationship was found between being on a team and a teacher's chance of having at least one positive collaborative relationship with a colleague. Ninety-two percent of teachers who reported that they were a member of a team also reported that they had at least one school-based colleague who exerted a strong positive influence on their teaching. This finding was drawn from the complete district survey sample, including (but not limited to) the six schools examined in Research Question 1. Results are shown in Table 5.

Though membership on such a team did not guarantee the flow of positive collegial influence, this finding provides support for the supposition that administrator-constructed teaming plays a key role in teachers' access to social capital.

Research Question 3

How do district leaders plan to use the findings to inform their theory of action and future school *reform and improvement efforts?* We share the results of

Table 5. Relationship Between Team Membership and Positive Relationships of Instructional Support.

		Is there at least one person in your school who has a strong positive influence on your teaching?		
		Yes	No	Total
Are you a member of at least one team that meets regularly and focuses on instruction?	Yes	771	68	839
	No	134	30	164
	Total	905	98	1003

Note. $\chi^2 = 16.15$, degrees of freedom = 1. $p < .001$.

facilitated partnership discussions in terms of what the district leadership group expressed as *confirming* ("We are glad that's happening!"), *surprising* ("Why is that happening?"), and *ideas for action* ("We should/could do that.").

Confirming. A statistically significant relationship was found between a teacher being on a team and her chance of having at least one positive collaborative relationship with a colleague. In addition, nearly all teachers expressed that being on a principal-assigned team was having a positive influence on their instruction. School leaders found these findings to be particularly confirming and reassuring. Administrators were very encouraged by what they saw as positive results of the district's focus on collaboration. "It really looks and feels like something good is happening in our teams," one teacher commented. A central office administrator noted,

> I feel like this [visual inspection of the sociograms] is really encouraging. It shows us that our push for collaboration may have had some really positive results. It's hard because, you know, we have really been pushing the idea that PLCs are the thing that's going to make a difference for our district, and we may have the feeling that it's doing good things, but it's good to have actual evidence.

They shared their sense of excitement to learn that their actions (to assign teachers to teams) is at least part of the reason that so many of their teachers have strong positive supportive relationships with colleagues. As an elementary school principal noted, "We are getting our teachers getting together and

they feel good about it. It's not a waste of time. It seems like what we are doing is making a difference."

Surprising. District personnel expressed surprise with what they perceived as a high number of teachers without strong positive support in their district. Between 3 and 21 teachers were shown to be isolates in the sample schools' instructional support networks, 10% of educators indicated that no other person in their school or district has a strong positive influence on their instructional practice, and 20% of teachers indicated that they are not a member of any team. One principal asked,

> Why do the formal networks in these schools look so different? We're all part of the same district, and we've all gotten the same directions and support [from the superintendent] about the establishment of PLCs and collaboration. I don't get why some schools have so many disconnected people.

Administrators could see how the findings revealed discrepancies in their logic model. They realized that even though teams/PLCs are a district focus, there are still many isolated teachers. District personnel speculated that some teachers may still have the attitude of "Close my door and leave me alone" and/or that principals may not be doing enough to ensure all teachers have to access a PLC.

Ideas for action. District partners publicly aired and recommitted to one another their shared belief that no teachers should be disconnected from their school's support network, that everyone must be on a team, and that *all* teachers should have at least one colleague who they go to for instructional support. In the very short term, school leaders planned to address the issue of isolated teachers. Principals planned to meet with their arts, special education, and ELL (English language learner) teachers to determine which teams they could be a part of, or if they ought to form a separate team. They discussed specific strategies for finding and making time for these new teams to meet, including "Thinking Outside the Clock" ideas offered by Yendol-Hoppey and Dana (2010).

Discussion and Implications

This study was situated in the larger discussion about the leadership choices and organizational structures that inhibit or facilitate teachers' access to social capital. Nearly all teachers in this study expressed truly valuing their formal and informal collegial relationships. This finding is important in light

of the long-standing claims about norms of autonomy and privacy among teachers (Elmore, 2007; Little, 1990; Lortie, 1975) and widespread contemporary school reformer enthusiasm for teacher collaboration and PLCs (Cochran-Smith & Lytle, 1999; McLaughlin & Talbert, 2006; Sargent & Hannum, 2009; Vescio, Ross, & Adams, 2008; Wood, 2007). Teachers want to collaborate, and their school leaders can help create formal organizational conditions for them to do so.

Implications for Research

Both formal and informal teacher collaboration are considered essential for deep change in schools. In this study, we sought to study the dynamic interplay between the formal and informal, and how such interplay may affect teacher access to instructional support. The field would benefit from a body of research that surfaces the specific organizational determinants that leverage formal and natural interaction among teachers, and how, in combination, the interplay cultivates social capital and meaningful instructional improvement.

However, administrator attention to increasing social capital in schools via formal and/or informal interaction among teachers does not in and of itself guarantee an increase in human capital. Being a member of an instructional team, or reporting access to strong positive support are not adequate levers for change (Robinson & Timperley, 2007; Timperley, 2008; Woodland & Mazur, 2015b). Collegial relationships can exist but may have only a negligible effect, if any, on teacher knowledge, skills, and practice.

This study was predicated on a fairly simple assumption about the value of teacher ties, namely that more supportive ties are better than fewer. It may not be the case, though, that a teacher with a large number of ties in fact has access to more resources; she may have multiple, redundant access points to the *same* resources (Burt, 2005; Granovetter, 1982). Therefore, future research that investigates how school leaders could by design increase teacher access to social capital would be strengthened by a concurrent examination of quality of collegial relations that are engendered by organizational design.

In her influential "continuum of collegial relations," Judith Warren Little (1990, p. 512) posited that teachers' professional interactions fall along a spectrum. Some, such as storytelling and sharing ideas, are independent activities that, while helpful, are unlikely to result in substantive lasting changes. Interdependent work, which Little terms "joint work," calls for "shared responsibility for the work of teaching . . .; collective conceptions of autonomy; support for teachers' initiative and leadership with regard to

professional practice; and group affiliations grounded in professional work" (p. 519). This holds with Timperley's (2008) assertion that in addition to membership on a team, teachers need "to have their current practice challenged and to be supported as they make changes" (p. 15). Hence, in addition to examining the predictors and interplay of formal and informal support networks, the field would also benefit from studies that examine the strength and quality of instructional support, that is, where network ties, including PLCs, fall on Little's (1990) continuum. We believe the field would benefit from a line of research that addresses nuanced questions about the intersection of formal and informal teacher collaboration, the quality of ties, and the effects of collegial interactions on instructional practice.

The sociometric survey design used in this study was created to efficiently elicit information about teachers' supportive relationships and the connection of those relationships to formal teams. The results of this study add new evidence to support the argument that organizational design affects teacher collaboration, and in the absence of formal teams, teachers may be constrained from accessing the resources potentially available to them in their school's instructional support networks. However, no causality can be inferred from the results. Although the data for this study show that a great deal of supportive ties correspond to shared membership on instructional teams, these data do not shed light on the extent to which those ties would exist anyway, even without the presence of a team. In addition, our study did not address the question of the persistence of ties over time. There is evidence to suggest that teachers' professional ties are susceptible to a high rate of "churn" from year to year (Bridwell-Mitchell & Cooc, 2016; Spillane & Shirrell, 2017). The field would benefit from continued research that explicates the variables that influence tie formation and dissolution.

Implications for Practice

Teacher collaboration is a predominant school reform approach that consistently shows promise for both teacher and student learning (Farley-Ripple & Buttram, 2015; Pounder, 1999; Ronfeldt et al., 2015; Slavit, Kennedy, Lean, Nelson, & Deuel, 2011; Sun et al., 2017). Teachers without access to the resources of the whole—without job-embedded social capital—are not likely to be as effective in the classroom (Bakkenes, De Brabander, & Imants, 1999). In this study, we found that the majority of "strong-positive" relationships between teachers are between those who also have a formal administrator-generated organizational tie. These findings suggest that administrators play a key role in creating conditions for effective collaboration. School leaders can enable teacher access to

instructional support and social capital through the creation of formal teams (e.g., PLCs) and by ensuring all teachers are a member of at least one team.

In addition to membership on formal teams, school leaders should attend to team/PLC processes—the ways that teachers work together that can result in everything from conviviality to the shared sense of purpose, frank and structured dialogue, and disciplined cycle of inquiry that are the hallmarks of productive collaboration. For example, it is widely known that dialogue is often a challenge in teacher teams; without clearly defined norms and processes, teachers often engage in idle chatter, gossip, or discussions about students or teaching challenges in general rather than specific matters of instructional practice (Achinstein, 2002; Dufour, 2003). Ensuring that all teachers are on an instructionally focused team, and helping teams elevate their level of dialogue, will likely produce noticeable decreases in isolates and will add to schools' ability to refine and reform teaching. School leaders may find Woodland's (2016) improvement science based framework for evaluating teacher collaboration useful for assessing and improving the quality of PLC process and outcomes.

Implications for University–District Partnerships

District personnel found the study's sociograms (Figure 3) to be uniquely useful for visualizing and analyzing district and school-level teaming landscapes. Every school principal expressed a strong desire for an accurate sociogram (network map) of teacher connections in their own school. As the high school principal asserted,

> These sociograms are compelling. I need to do what it takes to get a higher response rate to the survey so I can have a map and to see what was happening with teams and teachers in my own school. That information would be incredibly useful.

With a clear inventory or map of a school's or district's teaming landscape, administrators can more aptly ensure that all employees are connected to at least one team (i.e., that there are no isolates), that teams are composed of the right combination of members, and that they are neither too large or too small (Gajda & Koliba, 2007, 2008). Despite the relative novelty of SNA, school leaders had no trouble understanding the SNA's basic tenets or interpreting either visual or mathematical results. They appreciated using network maps to test their logic model/theory of action in "accessible and visually interesting ways." SNA may be a particularly useful way

of helping school leaders to engage in high-level, evidence-based discussions about school improvement and conditions for teacher collaboration.

Conclusion

The pace, depth, and direction of school reform initiatives are increasingly understood as being predicated on school-based social networks, that is, relationships through which teachers give and receive support for improving their instructional practice. This study used SNA to investigate the relationship between formal, administrator constructed ties and informal instructional support networks in an urban district. Nearly all teachers in this study expressed truly valuing their formal and informal collegial relationships, and a positive relationship was found between teacher access to high-quality instructional support and membership on an administrator created team. School leaders used the findings to reflect on their district's theory of change, reaffirmed their commitment to creating conditions for meaningful instructional improvement, and identified strategies to improve through teacher collaboration. Our study adds new evidence to the debate on whether and how to structure teacher collaboration, ideas for future research, and some guidance to educational leaders on how to better understand and use organizational design to leverage teacher collaboration. The significance of teacher collaboration for building instructional capacity and student achievement is widely recognized. Additional scholarly work that elucidates the organizational conditions that enable both formal and informal teacher support networks to effect meaningful instructional improvement will be of great value to the field.

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Note

1. This is approximately 44% of the district's non–central office instructional employees

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