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How Ideas Spread: Establishing a Networked Improvement Community

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Abstract

Challenges in scaling up effective reform initiatives have led to calls for new approaches to educational improvement at scale. Prior research on social networks focus on how pre-existing networks within schools shape reform implementation, yet networks may be more than analytic tools for understanding the spread of reform practices, but part of the organizational and social infrastructure that supports implementation and scale. This paper uses social network theory to move beyond Networked Improvement Communities (NICs) as ideal cases to empirically examine how NICs established in two large districts functioned. We find that networked interventions can shape patterns of interaction around reform, but require sustained structures to foster collective learning and cross-school engagement.

How Ideas Spread: Establishing a Networked Improvement Community

School reform has numerous examples of programs that have a positive impact on student outcomes and demonstrate initial implementation success, but encounter significant challenges while scaling up the reform (Datnow, 2005; Glennan, Bodilly, Galegher, & Kerr, 2004). These challenges in scaling up effective reform initiatives have led to calls for new approaches to educational improvement at scale, such as improvement science (Bryk, Gomez, Grunow, & LeMahieu, 2015; Cohen-Vogel et al., 2015), design-based implementation research (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013), and other forms of research-practice partnerships (Cohen-Vogel, Cannata, Rutledge, & Socol, 2016). While these approaches vary, they share an emphasis on developing the organizational and social infrastructure for districts to act as a learning organization and share emerging evidence about implementation across classrooms and schools (Murnane & Nelson, 2007). A district's infrastructure reflects the structures, cultures, and policies in which practice is enacted, but yet any given infrastructure can support or constrain improvement efforts (Hopkins & Woulfin, 2015).

The importance of organizational and social infrastructure for school reform has been emphasized by past research on how social networks shape teacher learning and enactment of school reform (Coburn & Russell, 2008; Daly & Finnigan, 2011; Frank, Zhao, & Borman, 2004; Wilhelm, Chen, Smith, & Frank, 2016). Educators are social actors constantly interpreting and reinterpreting their environment to make sense of what they are being asked to do (Coburn, 2001). This sensemaking process involves interpreting the demands of new programs through their past experiences and own ideas of good teaching (Coburn, 2001). Importantly, this process is shaped by the formal and informal organizational environment (Daly, 2010; Rorrer, Skrla, &

Scheurich, 2008). Central to the informal organizational environment is the social network of the school and district (Daly, 2010; Moolenaar & Daly, 2012).

Most research on social networks focus on how pre-existing networks within schools shape the diffusion and implementation of new practices (Daly & Finnigan, 2011; Frank et al., 2004; Moolenaar & Daly, 2012; Penuel, Frank, & Krause, 2010). Less attention has been paid to networked interventions (Moolenaar, 2012), that is, how the establishment of new organizational structures can shape improvement efforts. Yet there are many reasons to view networks as a mechanism for school improvement, such as fostering alignment between improvement efforts and individual school needs (Muijs, West, & Ainscow, 2010). Indeed, some of the new approaches to achieving scale leverage social networks to enact change (LeMahieu, Grunow, Baker, Nordstrum, & Gomez, 2017; Penuel, Bell, Bevan, Buffington, & Falk, 2016).

One such effort, improvement science, advocates for the formation of social networks through Networked Improvement Communities (NICs) focused on specific problems of practice as the mechanism to spread educational reforms (Bryk, Gomez, & Grunow, 2011). In this way, networks are not just analytic tools for understanding the spread of reform practices, but are part of the organizational and social infrastructure that supports implementation and scale. Here, we use social network theory to move beyond NICs as ideal cases to empirically examine how NICs established in two large districts functioned. We analyze how information about implementation spreads through a network and contributes to our understanding how the development of a formal reform network shapes informal patterns of interaction. Further, as these NICs reached beyond individual school campuses, this study helps us understand how social networks may or may not work to connect multiple schools, central office personnel, and external partners.

Understanding Networked Improvement Communities

Networked Improvement Communities (NICs) are used in improvement science as a mechanism to mobilize collective knowledge-building around complex problems and potential solutions, with various partners each contributing different forms of expertise (Bryk et al., 2011; LeMahieu et al., 2017). NICs are intentionally formed around a particular problem of practice, use common tools or routines to define their work, and emphasize collective learning and improvement (Cannata, Cohen-Vogel, & Sorum, 2017). Educational issues have a complex set of causes that require a "diverse colleagueship of expertise" that are "organized in ways that enhance the efficacy of individual efforts, align those efforts and increase the likelihood that a collection of such actions might accumulate towards efficacious solutions" (Bryk et al., 2011, p. 5). When organized within a NIC, individual schools learn not only from their own experience, but from the experiences of other schools who are working on similar problems of practice, thus, systematically pooling individual insights into a collective knowledge base (Bryk et al., 2015). The knowledge infrastructure necessary to reach this organizational capacity is particularly important when trying to achieve scale, as processes that work in specific contexts require significant transformation to ensure they are appropriate in other contexts (Engelbart, 1992).

To date, most research on NICs provides a theoretical or historical understanding, or present ideal cases (LeMahieu et al., 2017). Few studies have explored the internal working dynamics of these communities. There are two notable exceptions. First, Russell and colleagues (2017) conducted an empirical examination of the network initiation process, identifying five critical domains that must be attended to in establishing a NIC, such as learning improvement research methods and developing a shared theory of improvement. Similarly, Hannan and colleagues (2015) use qualitative comparative case study methods to understand the Building Teaching Effectiveness Network, finding that the NIC was successful in improving the support

structures offered to new teachers, but faced obstacles such as longstanding norms in schools that frustrate reform efforts. Other studies have examined how educators enact PDSA cycles, which is a key routine for collective learning in a NIC (Cannata, Redding, & Rubin, 2016; Tichnor-Wagner, Wachen, Cannata, & Cohen-Vogel, 2017). These studies, however, do not examine patterns of informal interactions among members in the network, which social network theory suggests has important implications for how reforms are implemented.

Social Network Theory

One way to understand NICs is through the lens of social network analysis, which can shed light on the flow and concentration of information throughout large networks inclusive of a wide and varied range of structures. Social network theory suggests that social networks shape how individuals understand educational reforms, respond to improvement efforts, and access resources (Daly, 2010). Research in education has found that social networks shape teacher learning and enactment of school reform (Coburn & Russell, 2008; Daly & Finnigan, 2011; Frank et al., 2004). Prior research on social networks in education finds that innovative practices are diffused through both pre-existing social relationships between individuals and relationships created or enhanced through district policies (Coburn & Russell, 2008; Frank et al., 2004).

Network Structure

Social network theory draws attention to the structure of the network, which includes features such as density, centrality, and boundary spanners (Borgatti & Ofem, 2010). These elements of social networks can help explain the ability of networks to solve problems of practice and the diffusion of ideas among network members (Borgatti & Ofem, 2010). For example, density, which is the proportion of all realized ties in a network divided by the total number of ties, provides evidence on whether there is an overall sense of cohesion in the network

(Moolenaar, 2012). Networks with higher density of connections are associated with greater trust between members, higher teacher self-efficacy, and greater enactment of school reform (Daly, Moolenaar, Bolivar, & Burke, 2010; Mohrman, Tenkasi, & Mohrman, 2003; Moolenaar & Sleegers, 2010; Siciliano, 2016).

The degree of centralization in a network is important as it shapes how relational structures support or constrain improvement efforts (Daly & Finnigan, 2011). For example, individuals that are highly central in a network have access to more resources and a larger influence on other members of the network (Moolenaar, 2012). As connections between individuals may or may not be reciprocal, social network researchers distinguish between in-degree centrality and out-degree centrality. An individual's in-degree centrality measures the number of network members who name them as a connection. An individual's out-degree centrality measures the number of network members named by the individual. While both are useful measures of centrality, in-degree centrality more closely reflects how much others come to someone for advice, while out-degree centrality more closely reflects how much that person is reaching out to others (Siciliano, 2016).

Given the importance of network structure, research has focused on how networks develop. Social networks reflect the informal connections between individuals and this pattern of interaction is influenced by the formal structures in a school, such as the use of grade-level or subject-matter teams and other collaborative structures (Penuel, Riel, et al., 2010). Yet networks may also differ from the formal organization. For example, principals clearly have an important role in the formal organization of a school, yet the principal may not necessarily be highly central to the informal social connections among school personnel (Moolenaar, 2012). Instead, other school staff may function as boundary spanners, who work across organizational

boundaries to spread reform knowledge across the district. Further, when reform efforts create new positions or forms of interaction, these structures are often evident in teacher social networks (Atteberry & Bryk, 2010; Baker-Doyle & Yoon, 2010; Coburn & Russell, 2008).

Spread of Information

Another key aspect of social networks is that they facilitate the diffusion of information and help teachers and other implementers get information about reform expectations (Daly, 2010). For example, when teachers' social networks include individuals with detailed knowledge about the district's new math curriculum, they were more likely to implement the ambitious instruction envisioned by the reform (Coburn, Russell, Kaufman, & Stein, 2012). Similarly, teachers who work in schools with less dense networks report feeling isolated and uncertain about what the reform looks like at other grade levels (Penuel, Riel, Krause, & Frank, 2009). More generally, research on teacher social networks finds that teachers vary in their access to expertise, and that access to expertise shapes teachers' enactment of reform practices (Daly et al., 2010; Frank et al., 2008, 2004; Penuel et al., 2009; Wilhelm et al., 2016).

That social networks shape the diffusion of information calls attention to the content of interactions. For example, Penuel (2009) and colleagues describe two schools that had similar levels of overall interactions between teachers, but differential access to expertise around reform practices was associated with the level of change. Similarly, creating opportunities for teachers to discuss reform initiatives in their schools can lead to greater enactment of reform practices than more traditional training alone (Yoon, Yom, Yang, & Liu, 2017). In particular, when teachers have strong ties, this facilitates problem-solving and the transfer of more complex knowledge (Daly, 2010). The importance of the content of interaction is also underscored in a

study of how district leaders use evidence for school reform. When evidence becomes narrowly defined, it can limit the use of research evidence (Finnigan, Daly, & Che, 2013).

The importance of the content of social interactions also points to a potential downside of social networks for school reform. While networks can provide access to expertise and new ideas, they can also constrain improvement efforts if interactions remain superficial or overly centralized, or if those with more centrality in the network lack buy-in or expertise (Daly & Finnigan, 2011). The limitations of social networks are well-documented in research outside of education, as networks can reinforce inequalities, restrict the freedom of network members, and close off opportunities for outsiders (Calvo-Armengol & Jackson, 2004; Portes, 1998).

In this study, we use both qualitative and quantitative data of similar networks established in two large districts to understand how the creation of a designated team of reform designers and leaders shaped the pattern of interactions across participants. We use data from a social network survey, interviews from network participants, and observations of network meetings to answer the following research questions:

1. To what extent does the informal social structure reflect the formal structure established through the Networked Improvement Community?
2. What predicts which members are considered helpful in the network?
3. How did network interactions evolve over time?

The social network survey provides most of the evidence for the first two questions and the qualitative data provides supplementary evidence on those questions and most of the evidence on the third question.

Data and Methods

Data come from NICs organized around high school improvement efforts in two large, urban school districts in two states. District A enrolls approximately 85,000 students across close to 150 schools. District B enrolls over 250,000 students across over 300 schools. The research team intentionally established NICs in each district as part of a continuous improvement approach to achieve scale (Cohen-Vogel et al., 2016). The NICs had different focal problems of practice based on initial case study research on effective practices across each district's high schools districts (Cannata, Smith, & Taylor Haynes, 2017; Rutledge, Cohen-Vogel, Osborne-Lampkin, & Roberts, 2015), but used similar structures and processes across four years. In District A, the work focused on developing Student Ownership and Responsibility (SOAR); in District B, the work on focused on building Personalization for Academic and Social Learning (PASL). The improvement process included: six monthly meetings to determine an initial design prototype (2012-13), 12-18 months to develop the prototype into a specific innovation and test related practices (2013-14), and two years of testing, revising, and implementing the developed innovation (2014-16). Three *innovation* high schools in each district participated in the initial design work and were the first sites of implementation. In 2015-16, the innovation was scaled to four additional *scale out* high schools in District A and five in District B. At the end of the 2016 school year, an additional seven schools joined the NIC in District B. In addition, researchers, program developers, district liaisons, and central office leaders participated in a district design team that supported school implementation.

In Spring 2016, the NIC in each district consisted of either seven or fifteen school-based teams (of around six people each), two researchers, three program developers, a district liaison, and between five and six central office leaders. Data come from three sources that span these four years: interviews with NIC members, observations and artifacts from NIC meetings, and a

network survey. We describe these next. To avoid confusion, we use the term "NIC" to refer to formal meetings and structures that were established as part of the improvement processes around SOAR/PASL. We use the term "network" to refer to the actual pattern of interactions that emerged between NIC members. All participants had particular roles in the NIC, but they may or may not have been central members of the network.

Interviews and Network Meeting Data

Members of each NIC consisted of participants in the District Innovation Design Team (DIDT), School Innovation Design Team (SIDT), and school administrators. The DIDT, which was responsible for developing the initial innovation design and providing district-wide leadership to the work, included central office personnel, university-based researchers, external program developers, representatives from participating schools, and representatives from other district high schools. The representatives of participating schools on the DIDT also served as coordinators of their school's SIDT, which was responsible for leading the innovation work in individual schools. Membership on the DIDT and SIDTs varied somewhat over the four years, mostly as individuals left the district or their school. In District A, there were a total of 39 DIDT members, 50 SIDT members, and 5 members who began as SIDT members and became DIDT members over time. In District B, there were a total of 46 DIDT members, 116 SIDT members, and 9 members who began as SIDT members and became DIDT members over time. DIDT and SIDT members were interviewed at several points in time over four years.

Table 1 provides information on the number of DIDT and SIDT interviews by semester. In total, there were 178 interviews in District A and 125 interviews in District B. The interview guides evolved over time, but generally focused on perceptions of the improvement process, successes and challenges experienced with this process, suggestions to further improve the work,

collaboration with other SIDT/DIDT members, and, for school-based members, how they lead the work in their schools. Some interviews were conducted in person while the researchers were engaging in fieldwork visits. Other interviews were conducted by phone.

Data also come from NIC meetings, which occurred monthly from Fall 2012 through Spring 2014 and then quarterly from Fall 2014 through Spring 2016 (October, January, April, and June). In addition, webinars took place occasionally over this time. During all NIC meetings, SIDT and DIDT members came together to share progress in each school and engage in a variety of capacity building activities led by the program developers. After the first year, the Plan, Do, Study, Act (PDSA) process (Cohen-Vogel et al., 2015) was introduced as a key routine to facilitate continuous improvement of their work around SOAR/PASL, where NIC meetings included time for school teams to share what they accomplished in their most recent PDSA cycle and plan the next one. After whole NIC meetings, there were meetings of only DIDT members to discuss broader issues and coordinate with district leaders. The DIDT and SIDT meetings offer fruitful data for exploring the improvement process, as these were working meetings where participants shared data and discussed what they were learning through the process. As SIDTs learned about what was happening in other schools and discussed implications for their own school, the meetings provided opportunities to observe directly how participants learned from one another through a networked improvement community. During each meeting or webinar, researchers completed field note logs on specific interactions. Audio recordings provided additional data on small groups that a data collector could not observe. In addition, participants completed feedback forms and the research team wrote a summary reflection on the day's events. Finally, materials distributed or created during the meeting were collected.

The NIC meeting and interview data provide insight into the organizational features of the network and the types of information that spread throughout the network. Transcribed interviews and meeting data were analyzed as part of the project's framework for innovation design and development. This framework consisted of several *a priori* codes in addition to codes that emerged inductively from the data. Relevant to the analysis here are codes related to engagement of NIC members, delivery of learning opportunities for network members, understanding of continuous improvement, engagement in PDSA cycles, evidence of learning across schools, role of the DIDT, role of the researchers, SIDT dynamics, and on-boarding of new schools. The coding process was iterative in nature with members of the research team comparing coding to ensure a consistent understanding and application of codes (Corbin & Strauss, 2008).

After the data were coded, analytic memos were prepared for each district by major code area, summarizing themes about patterns of interaction across network members that emerged in those codes for each district in each year and including evidence (i.e., quotes, vignettes from meetings) that substantiated those themes. Then, researchers systematically went through these memos searching for evidence about how learning opportunities structured interactions across NIC members, the content of information shared across members, and the extent to which specific members played a central role in their respective NIC. Other analyses of these data provide more information on the innovation development, implementation, and outcomes (Cannata & Nguyen, 2015; Cannata, Redding, & Nguyen, 2016; Redding, Cannata, & Miller, in press; Rubin, Patrick, & Goldring, 2017; Rutledge, Cannata, Brown, Redding, & Petrova, 2017; Rutledge, Socol, Harrison, Brown, & Preston, 2016). Here, we focus on interactions among NIC

members and how these interactions evolved over time. We use the qualitative data to illuminate findings from the network survey, described next.

Network Survey

The third source of data is a network survey that was administered in-person at the June 2016 meetings. The target population included all NIC members in 2015-16 who were either named prior to the meeting or were new to the NIC. These new attendees may have been new members of existing SIDTs or schools that were joining the NIC and forming new SIDTs. While school principals are not considered members of either the DIDT or their school's SIDT, given their role in implementation in their school, we included them as members for the network survey. In District A, we also included the nine district leaders who were tangentially involved in the NIC. A total of 52 participants in District A and 95 people in District B completed surveys. In District A, given the low level of involvement in the network of the nine district leaders, we exclude them from the analysis, yielding a response rate of 65 percent.[1] In District B, the response rate was 77 percent. See Table 2 for more information on the sample.

The survey was designed to understand the structure of the social network, including the existence of ties between individuals. Respondents first indicated the other people in the network with whom they had interacted with around the innovation in the past school year. They then described their frequency of interaction and how helpful that person had been on a four-point scale in regards to three tasks: developing innovation practices, supporting implementation, and engaging in continuous improvement around the innovation. The combination of the network survey and qualitative data allowed us to triangulate and substantiate findings from the other data

[1] If these participants are included, the response rate drops to 58 percent.

sources in a way that gave us a more nuanced perspective than if we relied on only one of these types of data (Smith, Cannata, & Taylor Haynes, 2016; Tashakkori & Teddlie, 2010).

Analytic Strategy

To describe how networks across these two districts aided in the dissemination of reform knowledge, we employ a mixed methods design. For the social network analysis, we adopted a bounded-saturated approach (Scott, 2000). We use the "igraph" and "sna" packages in R to conduct the social network analysis. We create several network measures, including the in-degree centrality, out-degree centrality, between-centrality, network density, and reciprocity. The number of ties is a count variable of the number of people an individual reported interacting with in their network. Centrality is the proportion of reported ties over all possible ties in the network. In-degree centrality measures incoming ties and can interpreted as prominence in the network. A participant with high in-degree centrality is important for the network as the individual serves as a source of information that other participants seek out. Out-degree centrality measures outgoing ties and can be interpreted as influence in the network (Hatch, Hill, & Roegman, 2016). Participants with high out-degree centrality play an important role in transmitting knowledge throughout the network. Betweenness centrality is a measure of how individuals connect different subgroups in the network. We use betweenness centrality to indicate how much the individual acts as a boundary spanner between schools. Network density is a proportion of all realized ties in a network divided by the total number of ties. To understand the mutuality of ties we also create a measure of reciprocity. Reciprocity is the number of individuals that indicate they are connected to one another over all possible dyads. In addition to these overall network measures, we used participants' responses to questions about other members' helpfulness in the

network. Our dependent variable of helpfulness averages across participants' responses about an individual's helpfulness on three domains, as responses across domains were highly correlated.

We use this measure in regression analysis to understand the individual teacher and school predictors of peer-reported helpfulness in the network. This model can be estimated:

$$helpful_i = \beta_0 + \beta_1 T_i + \beta_2 T_j + e_i \quad (1)$$

where T_i is a vector of teacher variables, S_j is a vector of school variables, and e_i is an error term. Teacher variables include the number of semesters a teacher has been involved, their role in the improvement work (SIDT, DIDT, district central office staff, and auxiliary, which includes program developers and researchers), and role in the district (teacher, administrator, support staff, and external). School characteristics include student enrollment, the fraction of low-income students, whether or not the school has been sanctioned by the state's accountability system in the last three years, and a measure of implementation quality for the 2015-2016 school year. Given the different district context in which each network arose, we estimate this model separately for each district. To account for the nonindependence of errors for observations of multiple participants in the same school, we cluster standard errors at the school level.

Table 3 reports descriptive statistics for the network members and the participating high schools across the districts. Schools in District B are larger, with an average of 2,291 students compared to 1,494 in District A. Schools in District A enroll more low-income students than District B (65.7% in District A versus 56.4% in District B). A larger percentage of schools in District A were sanctioned by the state's accountability system. The network in District A has more representation from the innovation schools, reflecting that District A had one fewer scale out school in Year 1 and no scale out schools in Year 2. Members in District A were more likely

to be SIDT members, more likely to be teachers, and had been involved in the reform for about one additional semester than members of District B.

Implementation quality measures are available for the innovation schools and Year 1 scale out schools. From visits to each school in Spring 2016 that included interviews with the DIDT/SIDT members, principals, teachers, and students, researchers in each district rated the core innovation practices (of which there were six in District A and five in District B) either a one (practice minimally observed), two (practice observed inconsistently throughout the school year), or three (practice implemented consistently throughout the year). After independently rating each practice, researchers met to reconcile differences. After differences were reconciled for each practice in each school, the median score was taken as the measure of implementation quality. Overall, implementation quality across the districts were similar.

Formal and Informal Network Structure

To answer the first research question about how the informal patterns of interaction were influenced by the formal structure established by the reform leaders, we use the social network survey. The focus of this analysis is to understand the existence and strength of ties between organizations (i.e., schools, central office, program developers, and researchers) and individual members. The final rows of Table 3 show the number of ties and measures of centrality, network density, and reciprocity. There is somewhat greater network density in District A compared to District B; 13% of all potential pairs were realized in District A versus 8% in District B. The lower network density in District B can be attributed, in large part, to the addition of five scale out schools late in the 2015-2016 school year whose members had less connections within the network. There was also a good deal of reciprocity in network interactions. Slightly less than half of relationships in both districts (44% and 46%) were reciprocated. While most members were

clearly identified with particular schools in the network, there was a substantial degree of interaction across schools. When network density and reciprocity are considered at the school-level (rather than individual), density is 78% in District A and 64% in District B, and reciprocity is over 80% in both districts. The tight, reciprocal connections between schools in the networks suggest that there are channels for knowledge about the innovation to be transmitted across school boundaries in each district. This is evidence that schools are connected to each other and that the researchers, program developers, and central office leaders have connections to most schools.

Figure 1 also suggests relatively dense networks in each district. Because of the overall complexity of the networks, for presentation, we find it useful to partition the network graph, replacing groups of vertices with single stakeholder groups that represent the school/organization (Kolaczyk & Csárdi, 2014). To highlight the importance of certain stakeholders in the network, the area of each node is proportional to vertex strength. Edges are weighted by the reported number of interactions. Figure 1 also highlights that the district and program developers have strong connections to schools, and that schools vary in their prominence in the network.

With initial evidence of cross-school network connections in both districts, we turn to Table 4 to understand differences in the network centrality of different participants. Table 4 indicates that the informal pattern of interactions among network members reflected the formal structure established in three main ways: (1) higher centrality of central office, program developers, and researchers compared to teachers and administrators; (2) higher centrality and cross-school ties of DIDT members compared to SIDT members; and (3) higher centrality and cross-school ties of innovation schools compared to scale out schools. First, in both districts, central office leaders had the highest measures of centrality and betweenness and the highest

number of ties. This high degree of prominence and influence suggests that central office staff played a key role in spreading ideas throughout the network, which we discuss below in greater detail using the qualitative data. In both districts, the members external to the district—the program developers and researchers—were also highly central to the network, with higher measures of centrality and betweenness, and more ties than school-based stakeholder groups. This suggests that each district's network was highly centralized, with the central office members, program developers, and researchers playing an influential role.

Further, length of involvement is also related to centrality in the network, with DIDT members more central to the network than SIDT members and innovation schools more central than scale out schools. Although this pattern holds for both districts, the differences are more stark in District A. For instance, in District A, the in-degree centrality is 0.17 for DIDT members compared to 0.10 for SIDT members. In District B, the in-degree centrality is 0.09 for DIDT members compared to 0.06 for SIDT members. In both districts, we find innovation schools members have higher centrality measures and more ties (both within-school and cross-school) than scale out schools. The scale out schools just joining the network in District B were the least central. This again suggests the informal pattern of interactions among network members reflected the formal structure established through the NIC. Table 4 also highlights some differences between the districts. In District A, school-based personnel had more within-school ties than cross-school ties; in other words, network members in District A mostly interacted with members from their same school. Members who were also on the DIDT or in innovation schools were exceptions to this pattern. In District B, however, teachers and administrators had more cross-school ties than within-school ties. This was particularly true for school administrators, who had twice as many ties to members in other schools than to those in their own school.

The qualitative data provide further evidence of the patterns identified in the survey. In terms of the centrality of central office personnel, the external partners in both districts hired a retired district administrator to serve as a district liaison, coordinating logistics and communicating with district and school-based members of the network. They also participated in planning meetings prior to each meeting, thus serving as a 'boundary spanner' between the external partners and the district (Star & Griesemer, 1989). A program developer talked about the role of the liaison in District B:

> And the one is that [liaison] has been critical in sort of shepherding and keeping in touch with critical people in the district. You know, on the upside to, he debriefs with [senior district leader] on a weekly basis. So his role there and working pretty closely with the district and the district leadership has been critical. And…on the other side is just his role in sort of facilitating and maintaining the contact with the school-based people, primarily the principals. He knows them all well. When he sends them a message, they respond to him in a moment. They know that he understands their situation very well…he has been a really critical person there for an outside intermediary agency.

Across both districts, the liaison not only fostered these relationships but also kept the school-based members involved by listening to their concerns. In this way, the district liaison became a central member of the network, connecting members from various schools and organizations. Other district leaders were also central members, although the qualitative evidence suggests their prominence stemmed from the authority with which they spoke rather than frequent interactions. For example, one member in District A said:

> I think different DIDT members are perceived as having different sort of levels of leadership ability in their own context, so I think district folks have some natural street cred, if you will…they have some natural authority that will be something that makes it easier for them to build capacity in SIDT [members].

The centrality of the program developers and researchers likely stemmed from their prominent role in in NIC meetings. In most meetings, the program developers were the main facilitators, both helping the NIC move between activities and often facilitating individual

activities. The researchers also played a prominent role, often facilitating activities, modeling a data inquiry process, and serving as a resource for data and research. A member from District B described how the program developers helped to move the work forward:

> "I think it was…kinda guiding us a little bit, you know, not so much that they want us to create a certain prototype, but just kind of keeping us on track. The, you know, whatever they were lecturing or whatever exercise we were doing, it was always moving us towards just the creation itself of some type of prototype."

In District A, a member spoke about building relationships: "I've actually built relationships with [researchers and program developers]…I've actually really enjoyed working with all of them, picking their brains, talking about educational research, I've enjoyed that." Across the data, we see evidence that researchers and program developers can play important roles in school-based improvement work and can become individuals who are sought out by other members.

The qualitative data provide additional evidence on the central role of innovation schools compared to scale out schools. When scale out schools joined the NIC, there was an active and ongoing emphasis to draw on resources developed by the innovation schools, which included structures such as assigning scale out school members to sit with innovation schools and descriptions of the SOAR/PASL tools they developed. For example, in District B, a district leader reminded the newest members that they had a plethora of resources to draw from, based on the many and varied experiences of the innovation and scale out school 'resident experts:'

> That's where our schools that have already been doing it are going to be a support. If it's a database, if it's a form, if it's a structure to an assembly with the PASL students, it's been done. So just say, here's what we did and make it fit for you and that's where our resident experts are going to help support over the next day plus to kind of support and answer all these questions and give you as much understanding so you can make it make as much sense as you can on your campus.

Importantly, members from the innovation schools, who were the first implementers of the innovation, were often considered mentors for the scale out schools or explicitly asked to share

what they learned with these schools. For example, an SIDT member at an innovation school said, "We've just been a resource for those other schools…whenever they need something…we help…we've been one of the pilot schools, we've been able to…help in whatever aspect that they may need it in." Similarly, a member from a scale out school in District A said,

> My principal is going to allow me to take a few teachers from my campus to [an innovation school] to observe some of those early adopter teachers that have already taught the growth mind set and problem-solving lessons, and then I also at the last meeting talked to the [school] teachers, kind of inform them… that I would love to have a couple of them come over maybe for a waiver day or faculty meeting or something and help me present out to my faculty.

Thus the innovation schools established connections to schools through serving as mentors and advisors in this improvement work.

The qualitative data illuminates how school administrators in the network developed cross-organization ties to inform their work. In both districts, school coordinators represented their school on the DIDT and served as leaders of their school's SIDT. In both districts, it is clear that these individuals played an important role in the network by representing their school. In both districts, participants heard from panels of (typically) school coordinators who shared their action plans. A school coordinator in District A described her/his role in a way that resonated with most of the other school coordinators across both districts. S/he shared:

> I took on a role of orchestrating meetings, planning, scheduling, the SIDT meeting and organizing and planning, the assignments, the things we had to do for the program… I worked a lot towards building our team at [school]. I put a lot of time and energy into — let's see — enlisting new teachers to our SIDT … And then at the end of the year I was involved in the presentation and — development of presentation of the materials to the district representatives.

There was a key difference in the school coordinators between districts, however. In District A, coordinators were mostly teachers, while in District B, they were all assistant principals. This meant that 17% of school-based members in District A were administrators,

compared to 32% in District B. This difference influenced the interactions between network members as they also had opportunities to interact in non-NIC specific, pre-existing organizational structures in the district. Administrators in both districts described districtwide meetings they would attend with other administrators. Yet because District B assistant principals were also their school's PASL coordinator, they used those opportunities to discuss PASL related work. As one school coordinator in District B said, "We have cadre meetings where we meet as a group of high school principals and PASL has come up several times. And I'm always the point person because in my cadre…my school is implementing it." These interactions between administrators became apparent to a teacher on the DIDT in District B, who also noticed that the administrators had other opportunities to communicate more frequently:

> The camaraderie between … the APs, you could tell that they all know each other and are communicating with each other. … there's probably a lot of communication between them off – off site, not as – not in terms of formal meetings, but you know, there's probably a lot of communication there.

SOAR coordinators in District A, who were mostly teachers, lacked these other district-wide meetings to further cross-school connections about SOAR. One school coordinator in District A said, "the size of our district and all the other pulls that we have, without structured time, I don't see us continuing to engage each other on this work on any consistent or regular basis." SOAR coordinators in District A expressed a desire for additional opportunities to connect with each other, but their role as classroom teachers created few such opportunities.

Who is Helpful in the Network?

In addition to understanding the overall structure of interactions in the network, another way to understand how the network works is to explore which individuals are considered most helpful when engaging in SOAR/PASL work, which is the focus of the second research question. Tables 5 and 6 present the regression results predicting stakeholders' peer-reported helpfulness

in the network in District A and B, respectively. Columns 1 and 2 predict helpfulness based on participants' length of participation in the network, role in the network, or role in the school. Columns 3 and 4 add school-level covariates, including demographic characteristics, the school's role in the improvement work, and measures of implementation quality. We include these school-level covariates to explore how school context shapes the flow of information in the network. Within a network that aims to share the most effective practices across schools, the expectation is that participants in the high or moderately implementing schools would be viewed as more helpful. When school characteristics are included in the model beginning in columns 3, the sample size is limited to members situated within schools, dropping members such as district central office staff, program developers, and researchers.

In District A, we find consistent evidence that a longer length of involvement is associated with greater peer-reported helpfulness in the network (see Table 5). Each additional semester of involvement is associated with an increase in peer-reported helpfulness ranging from 14% to 19% of a standard deviation, depending on the specification. We also find consistent evidence that SIDT members are the least helpful in the network when controlling for length of involvement. Instead, district central office staff, auxiliary members (program developers and researchers), and, to a lesser degree, DIDT members are predicted to be more helpful than SIDT members. Results from column 2 provide further evidence that stakeholders outside the school, either district central office staff or external partners, are seen as more helpful in the network.

When looking at school characteristics, we find strong evidence that, all else held constant, members in schools with moderate implementation quality are predicted to be 6.11 standard deviations more helpful than participants in schools with low implementation quality. Participants in schools with high implementation quality are predicted to be 2.18 standard

deviations more helpful than participants in schools with low implementation quality. A Wald test confirms that estimates on moderate and high implementation quality are significantly different from one another ($p = 0.03$). There is more inconsistent evidence of a relationship between the percentage of low-income students in a school, whether or not a school was sanctioned under the state accountability system, and peer-reported helpfulness. A percentage point increase low-income students is associated a 3% decrease in peer-reported helpfulness. Once controlling for implementation quality, this relationship shifts directions. The evidence is less consistent for schools that are sanctioned, although the direction of the coefficient suggests that participants in schools that are sanctioned may be seen as more helpful. Again, when controlling for implementation quality, the direction of this relationship shifts directions. Finally, there is no difference in the reported helpfulness of innovation and scale out school members, although this relationship may be masked by controlling for the length of involvement, as innovation school members have been involved for a longer period of time.

The results in Table 6 suggest that the characteristics associated with more perceived helpfulness varies between districts. For example, we find a weaker and less consistent relationship between length of involvement and peer-reported helpfulness. A semester increase in the length of involvement is associated with a 6% standard deviation increase in peer-reported helpfulness. However, when school-level covariates are added to the model, we find no evidence for this relationship. Unlike District A where auxiliary members were predicted the greatest degree of helpfulness, district central office staff are predicted to be the most helpful. Compared to SIDT members, central office staff are predicted to be 68% of a standard deviation more helpful, controlling for length of involvement. Auxiliary members are predicted to be less helpful

than SIDT members. We find no evidence in District B of a relationship between a participants' role in their school and peer-reported helpfulness.

In District B, we find less of a relationship between school characteristics and peer-reported helpfulness until we add the measure of implementation quality to the model. Notably, the direction in the relationship between implementation quality is opposite what is seen in District A. Compared to schools with low implementation quality, peer-reported helpfulness is predicted to be 1.73 standard deviations lower among participants in schools with high implementation quality. We also find slight evidence of a negative relationship between student enrollment and peer-reported helpfulness. As student enrollment increases by 100 students, there is a 4% standard deviation decrease in peer-reported helpfulness. Evidence from District B also suggests that a school's length of participation is related to participants' peer-reported helpfulness, even when controlling for individual's length of involvement. Compared to the initial innovation schools, participants in the scale out schools are predicted to be less helpful.

Overall, the data on perceived helpfulness for SOAR/PASL work suggests that individuals who had prominent roles in the formal NIC structure and had been involved in the SOAR/PASL work longer were considered to be more helpful than others in the network, particularly in District A. At the same time, members were considered more helpful if they were in schools with particular characteristics, such as schools that were not under state sanction and that served somewhat more low-income students.

That District B members were considered less helpful if they were in schools with high implementation quality is puzzling. However, closer examination of the qualitative data shed light on why particular schools were considered more or less helpful. One theme is the existing context and status of the school in the district, which may explain why members were considered

less helpful if they were in schools that were under state sanction. For example, a member in District B described how expectations for their school are rather low across many domains, not just PASL.

> They say, well, they're [school name] good …And unfortunately – [school name] good means like, you know, it's good for [school name], but when you compare it to other schools …there's just this like – I don't know if it's like, this mediocre expectation…

This school had somewhat low achievement but also served a high poverty student population; teachers at the school described a positive climate and strong instructional program that was not getting recognition because of the reputation it held in the district. The perceived status of this school in the district led to fewer members seeking them out for support in PASL, even though their school had strong implementation of PASL. Beyond issues of school context, the qualitative data also point to ways in which the personality or idiosyncratic characteristics of members shaped cross-school interactions. For example, some coordinators had more difficult personalities in large group settings. Because the coordinators were the most visible members of their team, that could inhibit members from other schools seeking out advice from that school.

Evolution of the Network

Early Network Interactions

The third research question focuses on how network interactions evolved over time. The social network survey was administered four years after the NICs were established. The qualitative data, which was collected throughout this period, provided evidence on how the network evolved. Activities in NIC meetings across this period had members working in both within- and cross-school groups. Within-school activities were planning oriented, with teams either developing implementation plans or PDSA cycles. Cross-school activities included time for schools to share what they learned in PDSA cycles or other accomplishments, in addition to a

number of small group activities such as jigsaws, where participants worked more closely together in cross-school teams to discuss issues around the innovation and concluded with whole group discussions of their learnings. In the first two years, the content of cross-school interactions focused on the specific practices of the innovation and what schools were actually doing to implement SOAR/PASL. However, attitudes toward early cross-school interactions varied and engagement was relatively low. For example, a typical activity in the NIC's early period included schools sharing what they tested in PDSA cycles and what they accomplished with that practice. Questions from members in other schools were often short clarifying questions, such as how often an advisory period meets or what types of lessons were used, with little extended discussion about the practices or how they contributed to SOAR/PASL.

This low engagement in cross-school learning in the NIC's first two years reflects the mixed attitudes members had about its usefulness. Some members valued these learning opportunities. For example, after a presentation in District A by one innovation school, a member from another innovation school commented that she enjoyed the activity as it allowed her to listen to the other schools' ideas and they may be able to be used at her school. "I think this is a good process for discovering ideas. Through group work, and collaboration, like this… I think we should continue doing this in the future because we gain a lot of ideas from other schools." Yet another District A member appeared to suggest these opportunities were less valuable, as s/he suggested replacing the time-consuming presentations by schools be replaced by a written summary: "have one of the study workers or somebody else compound that information of them coming in and paying attention and seeing what is it that this school is doing that is, that could be effective in other schools, and then … just sending it out in an email after." That a member thought s/he could learn just as much about what is happening in another school

by a written summary than attending a meeting across schools suggests there is low engagement with and low value seen in this type of interaction. The main reason members gave for low engagement in cross-school learning was a recognition that schools had different contexts and were in different places, making it hard to learn from each other. In District A, one member said:

> Another challenge from last year was just working with … every school… so that was very frustrating, the fact that we really wanted to take what we needed and go our way. Still, being able to give input to everyone else — because I think that's important — but it was frustrating when we had to work together all three schools on something.

Cross-School Engagement Increased Over Time

As time went on, members became more willing to deeply engage with each other about the practices they were implementing and the challenges of implementation itself. For example, at summer institutes at the end of the fourth year, both districts had rich discussions about the implementation challenges schools faced. During a panel discussion in District A, panelists from the innovation schools discussed challenges. Teams were very open to talking about challenges and how they had overcome them, which fostered a rich cross-school dialogue. As another example of deepening engagement, one member described how s/he changed her/his mind about the process of sharing their learning through PDSA with other schools. S/he said that, "PDSA has really helped me to think outside the box. When we were first presented this we were not really for it…but after every district meeting we have, we come back with something new and have been able to use it on campus."

Engagement increased as the content of the cross-school interactions evolved. Cross-school learning in District B in the third and fourth years also had more examples of schools sharing more than just the practices they were implementing. Many of the questions posed by the scale out school members were concrete and in reference to the organizational features of implementation. For example, members referenced the *logistics* of implementation based on

their experience, such as the quantity of teachers, students, whether or not they included 'new' teachers, how long the PD should last, and how they rolled SOAR/PASL out. Other questions related to learning about *strategies* such as getting 'naysayer' buy-in and details about the specific practices implemented, such as what they talk about during rapid check-ins and how they get teachers to do it 'intentionally.' Finally, many participants were curious about the *rationale* behind why the schools used the practices they did, such as the "Power of Period 1", and why they had not brought new teachers on yet. These types of questions tended to prompt discussions that made public the contextual differences between schools, allowing members to discuss how they can learn from a context that is slightly different from their own.

A second type of shift in network interactions occurred when the scale out schools joined, as the focus turned to onboarding the scale out schools to the network and greater differentiation in the activities offered to innovation and scale out schools. When the scale out schools joined at the end of the third year, network leaders offered more differentiated learning opportunities to meet the unique needs of the innovation school and scale out school participants, given the different stages of their knowledge bases. For example, differentiated workshops at the 2015 and 2016 summer institutes, allowed innovation schools to learn research findings specific to their schools and scale out schools to learn about the innovation itself from veteran school leaders. This format was effective in providing opportunities for the new scale out school members to deepen their knowledge about the innovation, while also providing innovation schools with opportunities to assume more responsibility and ownership of the process.

Discussion and Conclusion

This paper adds to the rich literature on social networks in education by attending to their role in networked improvement communities. In doing so, we move beyond the description of

Networked Improvement Communities as ideal cases (Bryk et al., 2015), to empirically examining how they function in two large urban districts. We find evidence that networks can mobilize collective learning, and that using networks as a core intervention strategy can shape social interactions. Yet, such learning must contend with the social context in which NICs are embedded. The literature has described how educators' sensemaking process is shaped by the formal and information organizational environment (Coburn, 2001; Daly, 2010). As part of this networked intervention (Moolenaar, 2012), a number of formal organizational structures were established to cultivate a network focused on targeted improvement efforts in each district. The primary structure was a network-wide quarterly meeting aimed at building the individual and collective expertise of participants on the district and school design teams.

In line with the theory of action, we found district central office and innovation school members to be most central in the network. This prominent role in the network emerged through their length of involvement and the expertise about the improvement process they developed during this tenure. In particular, school coordinators were empowered in the network by leading activities and district-wide meetings and representing their schools when sharing improvement efforts. Qualitative case study data indicates that the establishment of formal learning opportunities for the DIDT and SIDTs shaped the flow of information. Consistent with Daly (2010), the strong ties developed through participation in each network promoted the transfer of complex knowledge among participants, including strategies for aligning the shared improvement focus with distinct school needs, a central aim of NICs (Bryk et al., 2015).

District central office staff were essential in the spread of ideas throughout the networks in each district. Further, even though information was diffused broadly in the networks and we observed high levels of reciprocity at the school level, district staff evolved over time to function

as the hub of the network. In each district, these participants had the highest centrality. Importantly, these stakeholders included district liaisons that were former district administrators and paid to support the work of the program developers and researchers, who brought their extensive, pre-existing and trusting relationships with individuals through the schools and district. Pre-existing networks also aided in the flow of information among assistant principals who served as school coordinators in District B. Relationships with other administrators and routine meetings with colleagues at other schools allowed for the spread of improvement knowledge outside the formal quarterly meetings. Further, the centrality of the external developers and researchers is consistent with the theory of action of the network that draws on external partners to establish the network, but empowering district central office staff and DIDT members to sustain the work in the district.

DIDT members were also highly central in the network. With their long-term involvement in the reform as well their role in solidifying the backing of district and school leaders, DIDT members provided the logic and history of the innovations. Yet, the importance of DIDT members was not without drawbacks. The quality of implementation was always related to whether individuals were influential in the network, with the school's and their coordinator's status in the district shaping other members' perception of the work in their school. In this way, the flow of improvement knowledge through the network was not only contingent on the efficacy of a reform idea, but also on other contextual factors. These findings illustrate the importance of understanding the institutional context in which networks are embedded, as the knowledge exchange is shaped both by formal organizational structures and pre-existing district norms.

Cutting across both the qualitative and quantitative data is the importance of the social infrastructure that supported the development of these networks. This can be seen in the way that

the structure of the social network largely reflected the structures established by this improvement model, as well as the deepening engagement across schools as they learned from each other. In short, developing the social infrastructure of reform can aid its further implementation. In the NIC described in this study, the social infrastructure was intentionally established, reinforced, and sustained. Organizations who want to establish improvement networks should think carefully about how to organize the social infrastructure, such as the use of boundary spanners, development of long-term and multi-faceted relationships between members, access to expertise, and depth of interaction (Bridwell-Mitchell & Cooc, 2016; Daly & Finnigan, 2011; Penuel et al., 2009). This social infrastructure may require the involvement of external intermediaries (Honig, 2004; Peurach, Glazer, & Lenhoff, 2012).

Evidence from this paper indicates that new forms of educational improvement can be established in large urban districts and can promote the sharing of evidence about improvement efforts across schools within the district. The establishment of formal structures for sharing learning across schools also served to develop a collective knowledge base, as envisioned in the conceptualization of NICs (Bryk et al., 2015). Importantly, this paper contributes to the discussions of NICs that describe an ideal case of this reform model, by emphasizing how important it is to understand NICs within the contextual demands of school districts.

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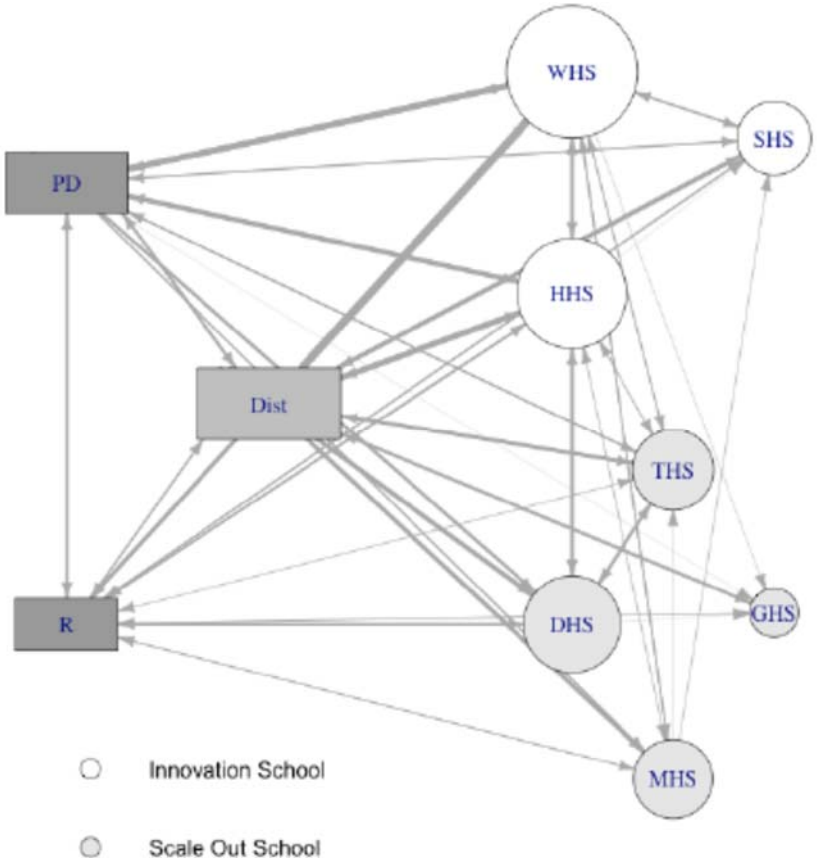
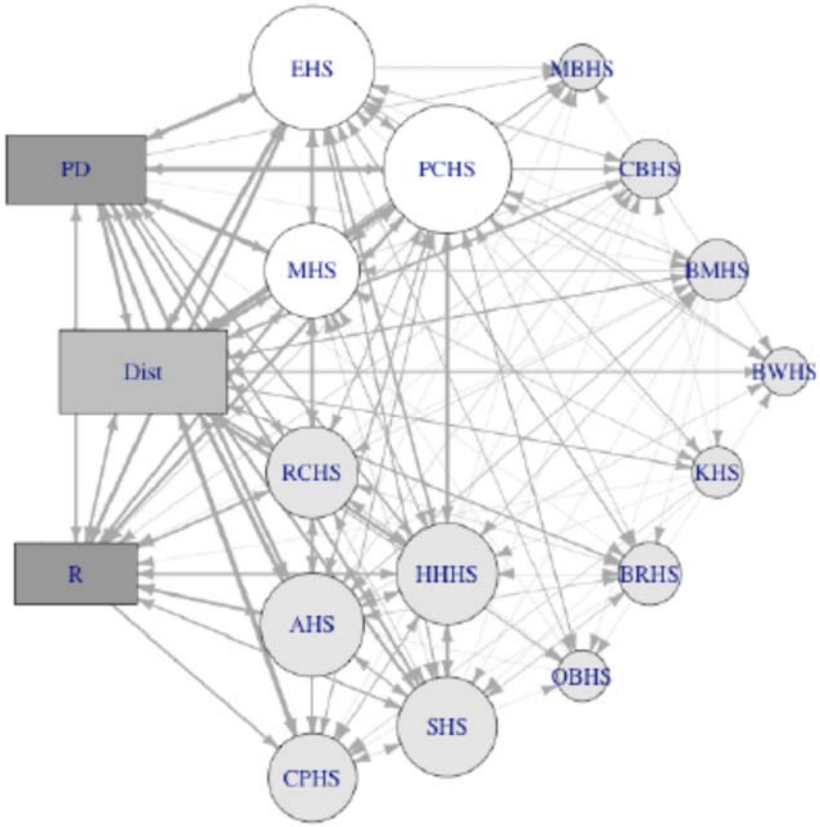
Tables and Figures





Panel A. District A Sociogram. Panel B. District B Sociogram.

Figure 1. Sociograms of network structure, aggregated to organizational level.

Table 1. Number of interviews with network members

	District A		District B	
	DIDT	SIDT	DIDT	SIDT
Spring 2013	n/a	n/a	23	n/a
Summer 2013	21	n/a	12	4
Fall 2013	16	8	3	n/a
Summer 2014	12	8	8	12
Fall 2014	11	9	n/a	n/a
Spring 2015	7	15	3	15
Fall 2015	14	n/a	6	9
Spring 2016	15	42	8	22

Note: In District A, there were four DIDT members and two SIDT members who were never interviewed. In District B, there were seven DIDT members and sixty-six SIDT members who were never interviewed. The large number of DIDT/SIDT members in District B who were never interviewed were predominantly the year 2 scale out schools who joined the network in June 2016.

Table 2 – Social Network Survey Data Collected In Each District

	District A	District B
Total Target Sample	80	123
Members named on the survey	72	88
Additional stakeholders	8	35
Number of Responses	52	95
Response Rate	65%	77%

Table 3. Descriptive Characteristics

	District A	District B
Schools		
Enrollment (100s)	14.94	22.91
% low-income students	65.67	56.43
Sanctioned	0.14	0.07
Innovation school	0.43	0.2
Scale out school (year 1)	0.57	0.33
Scale out school (year 2)	0.00	0.47
Implementation Quality	1.71	1.88
N	7	15
Network members		
Average peer-reported helpfulness (std)	0.31	0.17
Role in Improvement Work		
SIDT member	0.76	0.55
DIDT member	0.14	0.36
District central office staff	0.04	0.04
Auxiliary	0.06	0.04
Role in School		
Teacher	0.73	0.58
Administrator	0.15	0.29
Support Staff	0.03	0.04
External Stakeholder	0.10	0.09
Semesters Involved	5.54	4.59
Number of ties	9.97	9.06
In-degree centrality	0.13	0.08
Out-degree centrality	0.12	0.08
Network density	0.13	0.08
Reciprocity	0.44	0.46
Observations	80	116

Note. Implementation quality is measured on a 0-3 point scale.

Table 4. Participant Centrality and Ties, by Role in Improvement Work, School Involvement, and Role in District

	Role in improvement work		School involvement			Role in District				
	DIDT	SIDT	Innovation	Year 1 Scale out	Year 2 Scale out	Teacher	Administrator	Support Staff	District central office	External
In-degree centrality	0.17	0.10	0.13	0.09	n/a	0.11	0.13	0.11	0.31	0.27
Out-degree centrality	0.20	0.08	0.11	0.08	n/a	0.1	0.05	0.14	0.5	0.34
Betweenness centrality	0.01	0.002	0.003	0.004	n/a	0.004	0.003	0.002	0.07	0.02
Within-organization ties	6.27	3.84	5.11	3.16	n/a	4.40	2.50	9.00	1.33	1.60
Cross-organization ties	8.91	2.13	3.73	2.57	n/a	3.57	1.33	2.50	38.33	25.20
N	11	61	37	35	0	58	12	2	3	5
District B										
In-degree centrality	0.09	0.06	0.11	0.07	0.04	0.06	0.08	0.07	0.20	0.16
Out-degree centrality	0.07	0.05	0.09	0.07	0.03	0.06	0.07	0.03	0.26	0.25
Betweenness centrality	0.006	0.004	0.007	0.004	0.003	0.004	0.006	0.0002	0.03	0.01
Within-organization ties	2.98	2.66	3.76	3.54	1.5	2.76	2.76	3.20	2.40	1.40
Cross-organization ties	5.17	1.23	7.2	4.85	2.05	3.82	5.79	0.40	28.40	28.00
N	42	64	25	39	42	67	34	5	5	5

Table 5. Estimates from Models Predicting Peer-Reported Helpfulness in District A

	(1)	(2)	(3)	(4)
Semesters involved	0.14+	0.17*	0.19**	0.19**
	(0.07)	(0.07)	(0.05)	(0.05)
Role in Improvement Work				
DIDT	0.78+		0.51+	0.64*
	(0.42)		(0.25)	(0.19)
District central office staff	1.93*			
	(0.59)			
Auxiliary	2.08***			
	(0.29)			
Role in School				
Administrator		-0.39	-0.18	-0.10
		(0.36)	(0.26)	(0.26)
Support Staff		-0.64**	-0.38**	-0.35*
		(0.19)	(0.09)	(0.12)
External Stakeholder		1.76**		
		(0.43)		
School Characteristics				
Enrollment (100s)			-0.14	0.70*
			(0.07)	(0.22)
% low-income students			-0.04+	0.23*
			(0.02)	(0.08)
Sanctioned			0.25	-3.78*
			(0.33)	(1.24)
Scale out school (year 1)			0.38	
			(0.37)	
Moderate implementation quality				6.11*
				(1.83)
High implementation quality				2.18*
				(0.64)
Constant	-0.74**	-0.67**	-1.58**	-1.35**
	(0.17)	(0.17)	(0.36)	(0.29)
N	80	80	72	72

Note: Models 1 and 2 include all network members. Models 3 and 4 only include school-based network members.

Table 6. Estimates from Models Predicting Peer-Reported Helpfulness in District B

	(1)	(2)	(3)	(4)
Semesters involved	0.06*	0.06**	0.02	0.08
	(0.02)	(0.02)	(0.02)	(0.05)
Role in Improvement Work				
DIDT	0.15		0.43	0.02
	(0.15)		(0.38)	(0.72)
District central office staff	0.68**			
	(0.20)			
Auxiliary	-0.49+			
	(0.26)			
Role in School				
Administrator		-0.02	-0.33	-0.01
		(0.11)	(0.31)	(0.48)
Support Staff		0.09	-0.14	-0.14
		(0.33)	(0.43)	(0.50)
External Stakeholder		0.02		
		(0.44)		
School Characteristics				
Enrollment (100s)			-0.04+	-0.05***
			(0.02)	(0.01)
% low-income students			-0.00	0.04***
			(0.01)	(0.01)
Sanctioned			-0.12	-1.89***
			(0.33)	(0.32)
Scale out school (year 1)			-0.66*	
			(0.29)	
Scale out school (year 2)			-0.45+	
			(0.22)	
Moderate implementation quality				0.21
				(0.25)
High implementation quality				-1.73***
				(0.13)
Constant	-0.58***	-0.53***	0.13	-0.07
	(0.12)	(0.12)	(0.18)	(0.14)
N	116	116	106	64

Note: Models 1 and 2 include all network members. Models 3 and 4 only include school-based network members.