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How Ideas Spread: Establishing a Networked Improvement Community

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Abstract

Recurring challenges in scaling and sustaining educational improvement has led to new forms of educational improvement efforts (Bryk, Gomez, Grunow, & LeMahieu, 2015; Fishman, Penuel, Allen, Cheng, & Sabelli, 2013). One approach is the use of improvement science and the formation of Networked Improvement Communities (NICs) to spread educational reforms (Bryk et al., 2013). The research described here comes from a six-year partnership between our research team and two large districts to establish district NICs to improve high schools. This paper uses social network theory to understand how these communities operated and how information spread across individuals in the network.

How Ideas Spread: Establishing a Networked Improvement Community

The recent history of educational reform has focused on a multi-stage process of achieving success at scale: the identification and development of effective practices, rigorous testing of programs designed to improve less effective practices, and scaling proven programs to more schools. Yet research on the implementation and scaling up process has identified substantial challenges and limited results (Berends, Bodilly, & Kirby, 2002; Datnow, Hubbard, & Mehan, 2002; Glennan, Bodilly, Galegher, & Kerr, 2004). This research suggests that even programs that demonstrate positive outcomes through rigorous evaluation see diminishing returns when they are scaled (Chambers, Glasgow, & Stange, 2013). Explanations for these diminishing returns focus on the lack of an infrastructure for improvement within school systems (Peurach & Neumerski, 2015). In short, it is not the lack of awareness about effective programs that inhibits school improvement, but the lack of processes that allow school systems to act as learning organizations and share emerging evidence about implementation across classrooms and schools (Murnane & Nelson, 2007).

These challenges have led calls for new forms of educational improvement efforts, such as improvement science (Bryk et al., 2015), design-based implementation research (Fishman et al., 2013), and other forms of research-practice partnerships (Coburn & Penuel, 2016). These approaches, it is argued, focus on how organizational and social contexts shape how, and for whom, reforms work (Bryk, Gomez, Grunow, & Hallinan, 2011; Means & Penuel, 2005). These approaches also recognize that policymakers do not control the organizational, political, and technological processes that are required for successful implementation, which are often situated inside schools (Elmore, 1979). Re-focusing on educational improvement at scale, rather than

program implementation at scale, means recognizing that improvement comes not from just faithfully executing a highly developed program, but integrating new practices with existing systems and building collective knowledge about how practices lead to educational outcomes (Lewis, 2015).

Research on the implementation of effective programs also highlights the ways in which individual administrators and teachers learn about and enact new practices. This research has emphasized that 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; Allen & Penuel, 2015). 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). Indeed, social networks shape teacher learning and enactment of school reform (Coburn & Russell, 2008; Daly & Finnigan, 2011; Frank, Zhao, & Borman, 2004).

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 networks 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). The new approaches to achieving improvement at scale describe networks and partnerships as having a central role. 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 et al., 2013).

This paper uses social network theory to understand how Networked Improvement Communities established in two large districts operated and how information spread across individuals in the network. The unique features of this improvement effort lead to two key contributions of this research. One, since the NICs were intentionally established to improve practice in the focal areas, this paper explores the effectiveness of using networks to not only understand implementation, but as a central element of the improvement approach. Two, the NICs reached beyond individual school campuses and can help 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, Grunow, Baker, Nordstrum, & Gomez, 2017). Educational issues have a complex set of causes that require a “diverse collegueship 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 an 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 (Englebart, 1992).

To date, most research on NICs provide a theoretical or historical understanding of NICs, 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: learning improvement research methods, developing a shared theory of improvement, building a measurement infrastructure, leading and organizing the network, and fostering norms consistent with network aims (Russell et al., 2017). 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. These studies, however, do not use social network theory to understand the network structure, how information is spread across NICs, and how these networks shape the process of reform.

Social Network Theory

One way to more deeply understand NICs is through the use 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 find 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 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 and more organizational change (Mohrman, Tenkasi, & Mohrman, 2003; Moolenaar & Slegers, 2010). Further, more dense school networks are associated with higher teacher self-efficacy and greater enactment of school reform (Daly, Moolenaar, Bolivar, & Burke, 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 and cross 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 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 cohesive 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).

That social networks shape the diffusion of information calls attention to the content of what teachers are interacting around. For example, Penuel and colleagues describe two schools that had similar levels of overall interactions between teachers, but different access to expertise around reform practices was associated with the level of change (Penuel et al., 2009). 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 (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 those in the network, and close off opportunities for those outside of the network (Calvo-Armengol & Jackson, 2004; Portes, 1998).

This paper uses both qualitative and quantitative data of similar networks established in two large districts to understand the structure of social relationships and how information about the reform spreads across the network. We use data from a social network survey, interviews

from network participants, and observations of network meetings to answer the following research questions:

1. What is the structure of the social network established in each district?
2. How do organizational features of the established improvement process shape the network's structure?

After describing the data and methods, we first describe findings from the qualitative data the nature of interactions in each network and how these changed over time. We then use a social network survey to more formally analyze the structure of the social network.

Data and Methods

Data come from networks organized around high school reform 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 established distinct networks in each district; the networks had different focal problems of practice based on initial case study research in each district's high schools, 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 implementation of 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 other words, the network in District A included three innovation schools that were original members of the network, and four scale out schools that joined at the beginning of that school year. The network in District B included three innovation schools that were original members of the network, five scale out schools that joined at the beginning of that school year, and seven additional scale out schools that were preparing to begin implementation the next school year. In addition, researchers, program developers, district liaisons, and central office leaders participated in a district design team that supported school implementation.

In total in Spring 2016, the network 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. The larger number of SIDTs and DIDT members in District B is due to the addition of seven additional schools to the network at the end of the 2015-16 school year. Data come from three sources that span these four years: interviews with network members, observations and artifacts from network meetings, and a network survey. We describe these next.

Interviews and Network Meeting Data

Members of each network consisted of participants in the District Innovation Design Team (DIDT), School Innovation Design Team (SIDT), and school principals. The DIDT 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. 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 member 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 their perceptions of the improvement process, successes and challenges they have experienced with this process, suggestions to further improve the work, how they collaborate 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 broader fieldwork visits in the schools. Other interviews were conducted by phone.

Data also come from network meetings, which occurred monthly from Fall 2012 through Spring 2014 and then quarterly from Fall 2014 through Spring 2016 (October, January, April, and June). The June meeting was several days and was referred to as a Summer Institute. In addition, webinars took place occasionally over this time to serve as additional opportunities to engage across the network. During all network 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 was introduced as a key routine, where network meetings included time for school teams to share what they accomplished in their most recent PDSA cycle and plan the next one. After whole network meetings, there were meetings of only DIDT members to discuss broader issues and coordinate with district leaders. At these DIDT meetings, it was common for school principals to participate and, in District A, district leaders not officially on the DIDT would often attend.

These 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 network meeting and interview data help to describe 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 network members, delivery of learning opportunities for network members, understanding of continuous improvement, engagement in Plan, Do, Study, Act (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).

Across the four years, the work in District B was divided into five phases. District A began about six months after District B and the first two phases were collapsed so that District A

had four phases. After the data were coded, analytic memos were prepared for each district by major code area, summarizing the themes that emerged in those codes for each district in each phase of the work and including evidence (i.e., quotes, vignettes of meeting activities) that substantiated those themes. Then, researchers systematically went through these memos searching for evidence about how learning opportunities structured interaction across network members, the content of information shared across network members, and the extent to which specific network members played a central role in their respective NIC.

The combination of the network survey and quantitative data allows us to triangulate and substantiate findings from the other data sources in a way that gives us a more nuanced perspective than if we relied on only one of these types of data (Tashakkori & Teddlie, 2010). We rely on the quantitative network data (see below) to answer our first research question about the structure of the social network in each district. The qualitative data helps us to answer our second and third research questions about the organizational features of the improvement process and the information that flows through the networks. From the qualitative data, we also developed a series of hypotheses which we then tested in the quantitative analysis. In particular, as described below, the qualitative data drew our attention to whether schools were perceived as high or low performing in the district, the importance of network members' everyday role in their schools, and the extent to which schools were implementing the innovation practices with high quality.

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 individuals in the network in 2015-16 who were either named prior to the meeting or were new to the network. These new attendees may

have been new members of existing SIDTs or schools that were joining the network 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 network. . A total of 52 participants 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.

To describe how networks across these two districts aided in the dissemination of reform knowledge throughout the district, 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, 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.

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

In-degree centrality measures incoming ties and can be 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. 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. We calculate these measures first at the school level and then at the individual level.

In addition to these overall network measures, we used participants' responses to the questions about other members' helpfulness in the network. While the survey asked about helpfulness in three domains, responses were highly correlated. Our main dependent variable of helpfulness averages across all participants' responses about an individual's helpfulness on all three domains.

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:

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

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 the error term with observations of multiple participants in the same school, we cluster standard errors at the school level.

Table 3 reports descriptive statistics for participating high schools across these two districts. High schools in District B are larger, with an average of 2,291 students compared to 1,494 in District A. Participating schools in District A enroll more low-income students than District B (65.7% in District A versus 56.4% in District B). District A has more schools that were sanctioned by the state's accountability system, although there were also fewer total schools in District A. The network in District A has more representation from the innovation schools (who have been part of the network for longer), reflecting that District A had one fewer scale out school in Year 1 and no scale out schools in Year 2.

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.

Results

We begin by analyzing the interviews with network members and observations of network meetings to understand how members interacted during network meetings, as well as which members appeared to play important roles in the network. We describe each of these findings in turn.

Interactions in Network Meetings

Early Cross-School Interactions. The purpose of the network meetings was to bring together the SIDT and DIDT members from participating schools to engage in professional learning, facilitate cross-school and network learning, provide supported-working time for SIDT members, and, onboard new team members. In these network meetings, members worked together in within- and cross-school groups. Within-school activities were planning oriented, with teams either developing implementation plans or PDSA cycles. Members also participated in a number of small group activities, including several 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. Often, the program developers would assign members to specific small groups to ensure members from the same school participated in different groups. These conversations allowed participants to collectively deliberate on a variety of issues that they were struggling with, come to a shared understanding about the work, and brainstorm ideas. SIDT1303 found the cross-collaboration during the network meetings time useful, saying, "...to be pulled away for those meetings is – is helpful because you get to step away and think about what exactly you're trying to achieve, what's the next step and at least come up with a plan. And you're – I really like being able to talk to other schools."

Cross-school activities established norms of communication between innovation schools, allowed schools to give feedback to one another, and created structures for schools to cross-pollinate information about their individual organizational structures and local contexts. However, the evidence suggests that in the first two or so years of the network, the nature of information sharing across schools had relatively low engagement and was focused on getting ideas for practices to implement in their school. In these early years, questions after a school's presentation were often clarifying questions, such as how often an advisory period meets, or what types of lessons were used in advisory. Similarly, the feedback forms asked what members learned from collaborating across schools. Nearly all members who responded to this question said that they appreciated sharing best practices and seeing what is working in other schools. One member's comment is representative: "taking great ideas and using."

Members' perspective on the value of these cross-school learning opportunities varied. 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 DIDT member appeared to suggest these opportunities were less valuable, as he/she 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 and then 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 they've met with all three." That a DIDT member thought he/she 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 this type of interaction. In District B, members also described the learning that occurs across schools as a routine of sharing best practices. One SIDT member said, “I think they share best practices, documents are shared, you know, to each other that outline what all schools are doing in a sharing best practices mode.” A DIDT member from District B also described relatively low engagement in cross-school activities by saying:

Here's the thing. ... Everybody shares out. I'm not going to say that each time we're there I'm hearing perspectives from other schools and it causes me to play through in my head what we're doing and maybe tweak it... but I don't think any of the schools have ever questioned the steps that we took.

The main reason members gave for low engagement in cross-school learning was a recognition 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.

Related to these contextual challenges were the pre-existing perceptions that affected how schools interacted were pre-existing perceptions of the schools. For example, in District B, an SIDT member described how expectations for their school are rather low.

“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, and again, I don't know when it started. It just – it's sad, though. But the school's fantastic, you know? So I don't understand why that is even the case.”

Aside from these contextual factors that may have influenced the spread of information, also important is recognizing the ways in which members interacted outside of the scope of the NCSU work.

Cross-School Engaged Increased Over Time. As time went on, however, DIDT/SIDT members became more willing to deeply engage with each other about not only the practices they were implementing, but the challenges of implementation itself. For example, at the June 2016 Summer Institute, both districts had rich discussions about the implementation challenges schools faced. During a panel discussion in District A, panelists from the innovation schools shared their findings, taking questions from the audience. Panelists discussed challenges and how they have overcome them. Teams were very open to talking about challenges they have had, which fostered a rich cross-school dialogue. As another example of deepening engagement around the process of sharing across schools, in April 2016, a DIDT member described how she changed her mind about the process of sharing their learning through PDSA with other schools. She 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.”

Similarly, cross-school learning in District B in the most recent year had more examples of schools sharing more than just the practices they were implementing. Many of the questions posed by the scale out school teacher participants throughout the phase were concrete and in reference to the organizational features of implementation. For example, many were in reference to 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, how they rolled PASL out, and which class goal setting was taught in and which week(s). Other questions

asked 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 featured the differences between the school contexts. Some participants questioned the extent to which students were aware of PASL and what the perceptions were of the genuine nature of PASL.

Differentiation Between Innovation and Scale Out Schools. A second major shift in network interactions over time was due to the introduction of the scale out schools, as there was a focus on onboarding the scale out schools to the network and a greater differentiation in the activities offered to innovation and scale out schools. When the scale out schools joined the network, in June 2015, there were still whole group and small group activities, however there were also differentiated learning opportunities offered to meet the needs of the innovation school and scale out school participants, given the different stages they were at with their knowledge base. For example, at the 2015 and 2016 summer institutes, the differentiated nature of the workshops enabled the research team to focus the presentation of the research findings specific to the innovation schools, while the new scale out schools could be learning more about the innovation in a ‘gallery walk’ or poster session conducted by veteran DIDT members in a different room simultaneously. This format was effective at providing opportunities for the new scale out school members to deepen their knowledge about the innovation, while the innovation school members were provided with opportunities to assume more responsibility and ownership of the process.

Another meeting structure that was used to onboard the scale out schools served to foster collaboration between the innovation and scale out schools. For instance, during their first summer institute in both districts, the new scale out school members were instructed by the developers to evenly disperse between the innovation school working groups to observe and ask questions as they discussed their implementation plans for the upcoming school year. Overall, participants found the summer institute trainings useful. For example, a new member in District A described the importance of cross-school collaboration at the Summer Institute:

I was still kind of unsure of what my role was in this. It wasn't until the three days of training after the school year ended that we were all at the [professional development center] and we just spent three days really just working on what our vision was for our school and really honing in on that. That's really when I felt the most comfortable, so discussing -- seeing what other schools were doing, really that collaboration.

This onboarding included an active and ongoing emphasis on drawing on resources developed by the innovation schools. For example, in District B, the district leadership reminded the newest members that they had a plethora of resources in which 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 an 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 PASL/SOAR, were often considered mentors for the scale out schools or explicitly asked to share what they learned with the scale out schools. For example, an SIDT member at an innovation school said, "We've just been a resource for those other schools. So 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.

Roles of Prominent Network Members

A defining organizational feature the NICs in each district was the involvement of district stakeholders, school-based members, program developers, and researchers in the co-construction of the innovation. We describe how each of these role groups contributed to shaping network interactions.

Program Developers and Researchers. In all network meetings, the program developers and researchers played an important role. For example, in most meetings, the program developers were the main facilitators of the day’s agenda, both helping the network move between activities and often facilitating individual activities. The researchers also played a prominent role in network meetings, often facilitating activities about PASL/SOAR, modeling a data inquiry process, and serving as a resource for data and research on each meeting’s topic. Members spoke about the prominent role played by the developers and researchers. For example, a DIDT 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. And then when we all got together, you know, we, I guess we took everything that, you know, we heard, what made it a successful school or what we had done, and we just kind of put it all together.”

In District A, a member spoke about building relationships with the researchers and program developers: “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.”

School coordinators. 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 as representing their school. For example, in both districts, participants heard from panels of (typically) school coordinators who shared their action plans as well as any insights they had developed. A school coordinator in District A described his role in a way that resonated with most of the other school coordinators across both districts. 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 an important 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 difference did have an important influence on the interactions between network members as they also had opportunities to interact in non-network specific, pre-existing organizational structures in the district. 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, I’m the — you know, 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:

From the district meeting that I was at that 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.

There was also evidence that District A members who were assistant principals had similar opportunities to engage outside of network meetings. However, these members were fewer in number and not school coordinators. The school coordinators in District A, for the most part, did not have opportunities to interact with other DIDT/SIDT members outside of their school between network meetings. 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.”

District liaison. A critical member of the network was the district liaison. In both districts, a retired district administrator was hired to coordinate logistics and communicate 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. A program developer talked about the important 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 the other, 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, so there's a, you know, he has been a really critical person there for an outside intermediary agency to have that, you know, just given his history in the district and everything else.

Across both districts, the liaison not only fostered relationships between district personnel and the external developers and researchers, but also keeping the school-based members involved and listening to their concerns.

DIDT Members. While the program developers and researchers led most early activities, as time went on, DIDT members increasingly facilitated activities. This was particularly true when new members joined the network, such as when the SIDTs were formed (about six months after the DIDT) and when the scale out schools joined. For example, DIDT members led a gallery walk of each of the core components of PASL/SOAR at the summer institutes, a DIDT member led an training on growth mindset in District A, and DIDT members led a workshop on norms of engagement in District B. In the most recent year, one DIDT member from District A and two DIDT members from District B, all of whom were from the central office, took an increasing role in facilitating the DIDT meetings. These central office leaders also began providing input on the SIDT meeting agendas and working with schools.

Social Network Analysis

Another perspective on the nature of interactions between network members comes from 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 organization-level network density and reciprocity. We observe dense networks in both districts, with greater network density in District A compared to District B (78% versus 64%). The greater network density in District A can be attributed, in large part, to the addition of five scale out schools in District B late in the 2015-2016 school year. When these scale out schools are excluded from the analysis, the network density is 97%. The networks can also be characterized by high levels of reciprocity. In 91% of school-school dyads in District A, the relationship was reciprocated. In District B, 82% of relationships were reciprocated. The tight, reciprocal connections between schools in this network suggests that there are pathways for knowledge about the innovation to be transmitted

throughout each district. 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 evidence of highly connected networks in both districts, we next turn to Table 4 to understand differences in the centrality of different schools. In both districts, central office staff leaders played a key role, as they had the highest measures of centrality and highest number of ties. At least one participant in every school reports having contact with a district staff member, including the district liaison, while district staff report having a connection with at least one person in every school. This high degree of prominence and influence suggests that central office staff play a central role in spreading ideas throughout the network, which we discuss below in greater detail. In District A, the program developers and researchers are also highly central to the network, with higher centrality measures than two of the innovation schools, and more ties than all schools. This suggests that the network in District A is highly centralized, with the central office members, program developers, and researchers playing an influential role. In District B, the program developers and researchers have measures of centrality that are comparable to the least central innovation schools and most central scale out schools. They do have more ties than all the innovation schools, suggesting that the program developers and researchers are influential in the network, but perhaps not as central as they are in District A. In District B, the program

developers play a larger role in transmitting knowledge than individuals seeking them out. We find the opposite to be true for researchers, who are more likely to be sought out than share with the group.

The networks in this study began with three innovation schools, before new scale out schools were integrated into each district's network. As such, we would expect the innovation schools in each district to have greater prominence compared to other schools in the district. In District A, the results generally confirm that the network conforms to this hypothesis. Williams High School (WHS) and Hancock High School (HHS) have the highest in-degree and out-degree centrality of any school in the district. Participants at WHS report talking to at least one participant at every other school in the district. Participants at these two schools also have the greatest number of ties. At WHS, participants have an average of 12.5 ties. At HHS, participants have an average of 9.55 ties. Smith High School (SHS) is an exception to this pattern. Participants report outgoing connections with someone in less than half of the schools.

In District B, there is a similar pattern. Among schools, the innovation schools—Egret High School (EHS), Mariposa High School (MHS), and Panther Cove High School (PCHS)—are the most prominent. In other words, participants in the innovation schools are an important source of information that is sought out by participants at other schools. MHS has less out-degree centrality, suggesting that participants at this school play less of a role in transferring information throughout the network. Participants at MHS average only 5.6 ties, fewer ties than most of the other first year scale out schools. The scale out schools who began implementation in the 2015-2016 school year have the next highest in-degree and out-degree centrality. The in-degree centrality ranges from 0.65 to 0.76 while the out-degree centrality ranges from 0.47 to 0.82. Finally, the scale out schools just joining the network are the least central.

In addition to understanding the centrality of organizations in these networks, we also explored the role of specific individuals in the network. We now use the network survey to model which individuals were considered more helpful in the network. Table 5 presents descriptive statistics and measures of centrality at the individual level in each of the districts. In both districts, the majority of participants in the network were SIDT members. This includes 76% of participants in District A and 55% in District B. District B has a greater relative share of members on the DIDD. In terms of the role in the school, one notable feature separates the two districts. District A has more teachers involved in the network compared to District B that has a greater administrator presence. In District A, 73% of members are teachers compared to 58% in District B. In contrast, 29% of participants in District B are administrators compared to only 15% in District A. Participants have been involved an average of one additional semester in District A (5.54 versus 4.59). This difference is driven by the large number of new members to join the scale out process in District B. Participants in District A have slightly higher centrality and the network is slightly denser (13% compared to 8%). That being said, just under half of all relationships are reciprocated in each district.

Tables 6 and 7 presents 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 to 5 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 hope would be 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 6). 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 partners external to the district, are seen as more helpful in the network. The peer-reported helpfulness of external stakeholders is predicted to be 1.76 standard deviations greater compared to teachers. Support staff such as guidance counselors or librarians are predicted to be less helpful than teachers.

When looking at school characteristics, we find strong evidence that, all else held constant, members in schools with moderate implementation quality are predicted 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 district 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 7 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% of 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, holding all else constant.

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 networks 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, with one exception in District A, 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 out on their improvement efforts. Qualitative case study data indicates that the establishment of formal learning opportunities for the district and school design teams shaped the flow of information. Consistent with Daly (2010), the strong ties developed through participation in each network promoted the transfer of more complex knowledge among participants. This complex knowledge included 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 functioned as the hub of the network. In each district, these participants had the highest centrality. Importantly, these stakeholders included district liaisons who had formerly worked as administrators in the district, were trusted by school participants, and had extensive, pre-existing networks with which to spread the improvement work throughout the 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 DITD members to sustain the work in the district.

DITD 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, DITD members provided the logic and history of the innovations. Yet, the importance of DITD members was not without drawbacks, as it takes more than interaction to access expertise (Penuel et al., 2009). In District B, the school with the highest quality implementation was not consistently sought out for their expertise, potentially because of a broader perception that the school was low-performing. In this way, the flow of improvement knowledge through the network was not only contingent on the efficacy of a reform idea, but other contextual factors. These findings illustrate the importance of understanding the institutional context in which networks are embedded, as the exchange of knowledge is not only shaped by formal organizational structures but pre-existing norms within the district.

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. Yet, we find that this social infrastructure must be 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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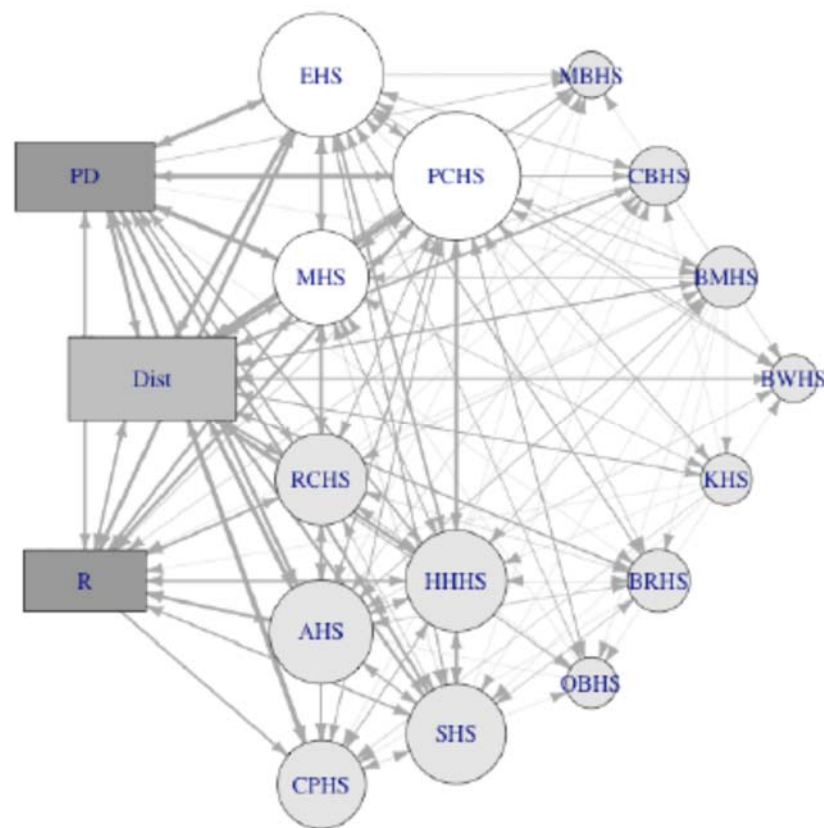
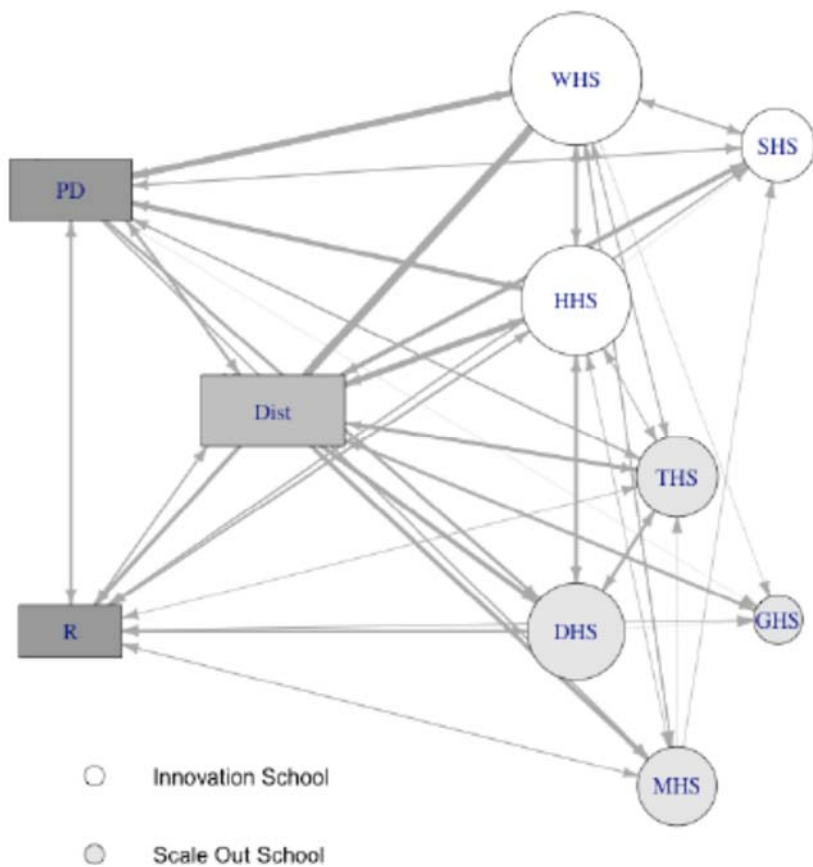
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Tables and Figures



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. Average School Characteristics

| | District A | District B |
|---------------------------|------------|------------|
| 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 |
| Network density | 0.78 | 0.64 |
| Reciprocity | 0.91 | 0.82 |
| Observations | 7 | 15 |

Note. Implementation quality is measured on a 1-3 point scale.

Table 4. Organizational Centrality

| | Centrality | | Number of Ties |
|-----------------------------------|------------|------------|----------------|
| | In-degree | Out-degree | |
| District A Average | .75 | .77 | 9.98 |
| <i>Innovation Schools</i> | | | |
| Williams (WHS) | .89 | 1 | 12.5 |
| Hancock (HHS) | .78 | .89 | 9.55 |
| Smith (SHS) | .67 | .44 | 2.9 |
| <i>Scale Out Schools (Year 1)</i> | | | |
| Davis (DHS) | .67 | .78 | 6.69 |
| Marsalis (MHS) | .56 | .78 | 7.88 |
| Goodman (GHS) | .56 | .22 | 1.4 |
| Tatum (THS) | .78 | .67 | 6 |
| District Central Office Leaders | 1 | 1 | 39.67 |
| Program Developers | .89 | 1 | 27 |
| Researchers | 1 | 1 | 26.5 |
| District B Average | .66 | .65 | 9.06 |
| <i>Innovation Schools</i> | | | |
| Egret (EHS) | .94 | .88 | 10.78 |
| Mariposa (MHS) | .82 | .65 | 5.6 |
| Panther Cover (PCHS) | .88 | .88 | 13.55 |
| <i>Scale Out Schools (Year 1)</i> | | | |
| Red Cypress (RCHS) | .65 | .82 | 9.5 |
| Amaranth (AHS) | .76 | .82 | 7.75 |
| Coconut Palm (CPHS) | .71 | .47 | 5.38 |
| Hemlock Hills (HHHS) | .76 | .76 | 10.86 |
| Sawgrass (SHS) | .76 | .76 | 8.9 |
| <i>Scale Out Schools (Year 2)</i> | | | |
| Manatee Bay (MBHS) | .41 | .12 | 1.57 |
| Citrus Bay (CBHS) | .41 | .47 | 3.83 |
| Blue Marlin (BMHS) | .35 | .82 | 5.2 |
| Big Wave (BWHS) | .41 | .24 | 2.5 |
| Kingfisher (KHS) | .24 | .53 | 3.83 |
| Blue River (BRHS) | .53 | .59 | 3.8 |
| Ocean Breeze (OBHS) | .41 | .29 | 4.57 |
| District Central Office Leaders | 1 | 1 | 30.8 |
| Program Developers | .65 | .82 | 37.33 |
| Researchers | .88 | .65 | 17.5 |

N = 28

Table 5. Participant Characteristics, Perceived Helpfulness, and Centrality

| | District A | District B |
|---|------------|------------|
| 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 |

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

| | (1) | (2) | (3) | (4) | (5) |
|---------------------------------|---------|---------|--------|---------|---------|
| Semesters involved | 0.14+ | 0.17* | 0.15* | 0.19** | 0.19** |
| | (0.07) | (0.07) | (0.06) | (0.05) | (0.05) |
| Role in Improvement Work | | | | | |
| DIDT | 0.78+ | | 0.62+ | 0.51+ | 0.64* |
| | (0.42) | | (0.29) | (0.25) | (0.19) |
| District central office staff | 1.93* | | | | |
| | (0.59) | | | | |
| Auxiliary | 2.08*** | | | | |
| | (0.29) | | | | |
| Role in School | | | | | |
| Administrator | | -0.39 | -0.08 | -0.18 | -0.10 |
| | | (0.36) | (0.28) | (0.26) | (0.26) |
| Support Staff | | -0.64** | -0.42* | -0.38** | -0.35* |
| | | (0.19) | (0.15) | (0.09) | (0.12) |
| External Stakeholder | | 1.76** | | | |
| | | (0.43) | | | |
| School Characteristics | | | | | |
| Enrollment (100s) | | | -0.12 | -0.14 | 0.70* |
| | | | (0.07) | (0.07) | (0.22) |
| % low-income students | | | -0.03+ | -0.04+ | 0.23* |
| | | | (0.02) | (0.02) | (0.08) |
| Sanctioned | | | 0.42+ | 0.25 | -3.78* |
| | | | (0.20) | (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** | -1.21* | -1.58** | -1.35** |
| | (0.17) | (0.17) | (0.39) | (0.36) | (0.29) |
| N | 80 | 80 | 72 | 72 | 72 |

Note. Standard errors clustered at the school level reported in parentheses. + $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 7. Estimates from Models Predicting Peer-Reported Helpfulness in District B

| | (1) | (2) | (3) | (4) | (5) |
|---------------------------------|----------|----------|--------|--------|----------|
| Semesters involved | 0.06* | 0.06** | 0.05 | 0.02 | 0.08 |
| | (0.02) | (0.02) | (0.03) | (0.02) | (0.05) |
| Role in Improvement Work | | | | | |
| DIDT | 0.15 | | 0.40 | 0.43 | 0.02 |
| | (0.15) | | (0.37) | (0.38) | (0.72) |
| District central office staff | 0.68** | | | | |
| | (0.20) | | | | |
| Auxiliary | -0.49+ | | | | |
| | (0.26) | | | | |
| Role in School | | | | | |
| Administrator | | -0.02 | -0.38 | -0.33 | -0.01 |
| | | (0.11) | (0.28) | (0.31) | (0.48) |
| Support Staff | | 0.09 | -0.21 | -0.14 | -0.14 |
| | | (0.33) | (0.40) | (0.43) | (0.50) |
| External Stakeholder | | 0.02 | | | |
| | | (0.44) | | | |
| School Characteristics | | | | | |
| Enrollment (100s) | | | -0.02 | -0.04+ | -0.05*** |
| | | | (0.02) | (0.02) | (0.01) |
| % low-income students | | | 0.01 | -0.00 | 0.04*** |
| | | | (0.01) | (0.01) | (0.01) |
| Sanctioned | | | -0.50 | -0.12 | -1.89*** |
| | | | (0.28) | (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*** | -0.36* | 0.13 | -0.07 |
| | (0.12) | (0.12) | (0.15) | (0.18) | (0.14) |
| N | 116 | 116 | 106 | 106 | 64 |

Note. Standard errors clustered at the school level reported in parentheses. + $p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$