In the NIC of Time: How Sustainable are Networked Improvement Communities?

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Abstract

Networked Improvement Communities (NICs) mark a promising approach to address the challenges of sustaining school reform. While NICs are intended to help scale and sustain reforms, there is little evidence on how this works, as few NICs have existed long enough to be described over time. This study uses social network theory to understand what happened after the removal of external supports for a NIC regarding the sustainability of the improvement efforts as well as the NIC itself. We use social network data and interviews conducted with 77 school and district leaders within the NIC to examine changes in the organizational infrastructure that maintained or changed features of the NIC. Our findings indicate that, upon the withdrawal of external supports, core network features were maintained. However, changes to the network, such as a reliance on teacher-leaders and a focus on school-level empowerment, present challenges to the long-term sustainability of the NIC.

To many, the sustainability of educational reforms is the true marker of success (Coburn 2003; Datnow 2005; Hargreaves and Goodson 2006; McLaughlin and Mitra 2001). For a reform to be sustained following the withdrawal of external support, it must be institutionalized—that is—embedded into school and district norms and organizational structures (Datnow 2005; McLaughlin and Mitra 2001; Redding, Cannata, and Taylor Haynes 2017). Yet, the success of efforts to reform and sustain teacher and school practices have generally been underwhelming.

Networked Improvement Communities (NICs) have been proposed as a potential solution to address challenges of sustainability. NICs are consciously formed networks of local school and district stakeholders, researchers, and program developers focused on addressing persistent educational problems (Bryk et al. 2015). Three features of NICs demonstrate their potential to overcome challenges of sustainability to preserve educational improvements. First, NICs are formed in ways that elicit the expertise of diverse stakeholders throughout the district (Bryk and Gomez 2008; Bryk, Gomez, and Grunow 2011). This increased ownership and understanding of the reform among diverse stakeholders can help to sustain reforms through policy changes and staff turnover as there is less reliance on a single individual to set policy and lead the reform (Russell, Bryk, Dolle, Gomez, Lemahieu, et al. 2017). Second, the involvement of various stakeholders is also aimed at developing innovative solutions that can be imbedded in the specific contexts present across the network. Prior research has shown that the involvement of local stakeholders in the development of school reform creates a high degree of alignment between the innovation design and preexisting organizational processes (Redding and Viano 2018; Tichnor-Wagner et al. 2018). Third, the social ties developed through NICs form the basis of an improvement infrastructure that can manage the ongoing implementation of the reform once external support is withdrawn (Bryk et al. 2015a; Coburn et al. 2012).

While NICs are an emerging approach to innovation design and implementation, there is little empirical evidence on them. Russell and colleagues (2017) focus on the process of launching a NIC, but less attention has been paid to the developmental trajectory of NICs over time and their impact on informal social networks. The potential of NICs to shape reform sustainability draws on prior research that has documented the role of social networks in promoting organizational learning (Coburn, Mata, and Choi 2013). Yet, research also points to the difficulties of sustaining networks when the formal organizational structure changes (Spillane and Shirrell 2017). As sustainability is a chief concern of networked improvement communities (Cohen-Vogel et al. 2015), evidence of how they are sustained is essential, but few NICs have existed long enough to be described over time.

This paper uses social network theory to understand how a NIC survived the removal of external support while still attempting to sustain the improvement efforts in each participating school. Our contribution to the literature is twofold. First, we add to the growing body of literature on NICs by examining the important question of how the NIC changes following the withdrawal of external support. Using a rich data set of interview and social network data, we can identify both the changes in the network structure and the organizational infrastructure that contributes to these changes. Second, this study speaks to the broader literature on sustainability. Since NICs are designed with the intention of being sustained once reform ownership shifts to local stakeholders, understanding the sustainability of NICs is an important concern. Our data allow us to examine both the network features that allowed the reform and the network to sustain as well as the district- and school-level supports that maintained the reform efforts.

In this study, we aim to answer the following:

1) How did the organizational infrastructure change upon withdrawal of external supports?

2) In what ways did the network interactions and structure change upon withdrawal of external supports?
3) What are the implications for sustainability of the network due to changes in the network?

Challenges of Sustaining Reform Efforts

Although sustainability is a goal for many school reform initiatives, attaining this goal has been elusive (Hargreaves and Goodson 2006). In one study representative of the challenges of sustaining school reform, Datnow (2005) finds that within six years of reform adoption, most of the 13 elementary schools studied had discontinued the reform due to changes in organizational infrastructure. Broadly, the literature identifies three key factors that hinder the sustainability of educational innovations: (1) state, district, and school policy changes, (2) turnover of teachers and school leaders, and (3) a lack of reform alignment with school structures (Datnow 2005; Friend et al. 2014; Sindelar et al. 2006). Changes in policy may incentivize teachers to pursue activities more closely aligned with new organizational goals. New teachers without knowledge or training on the reform are less likely to adequately implement reform practices. Finally, a lack of reform alignment with school structures may deplete reform efforts of key resources such as funding and time for training.

Despite barriers to sustainability, research suggests that the presence of supportive networks among teachers and district leaders may help sustain reform efforts (Coburn et al. 2012; Sanders 2012). Studies by both Dresner and Worley (2006) and Coburn and colleagues (2012) find a relationship between teachers' social ties and the sustainability of reform efforts upon the withdrawal of external supports. Networks with strong ties, in-depth interactions, and high expertise helped teachers sustain the work during the period of adjustment. For example,

Dresner and Worley (2006) study teachers participating in a science professional development network five years after its inception. Using data from participant interviews, they find that teachers' collegial relationships and sustained interactions with other teachers and scientists in the network were helpful in the continued implementation of practices learned during the training. Coburn and coauthors' (2012) social network analysis maps the relationship between the strength of a naturally formed teacher social network and the sustainability of an instructional reform. They find that various network structures helped teachers adjust their instructional approaches in response to new changes in the environment while still maintaining core tenants of the reform. Work by Sanders (2012) highlights the key role played by district coordinators in facilitating information transfer and relationship building during a successfully sustained reform effort. This research is noteworthy in that it points to the ways strong interpersonal ties between teachers, school and district leaders, and reform developers can help reform work by facilitating knowledge transfer and providing peer support. Thus, while external factors such as policy changes, employee churn, and resource availability may create challenges for sustainability, interpersonal relationships appear to strengthen the durability of reform efforts.

Literature on the role of social capital in school improvement echoes this evidence, arguing that access to social capital is a key factor in the successful diffusion and potential sustainability of school reforms (Frank, Zhao, and Borman 2004; Kahne et al. 2001). Social capital refers to the relationships between stakeholders, both between and across communities (Kahne et al. 2001). Coleman (1988) defined network capital as the social relations that facilitate access to information, while trust is the extent to which stakeholders expect that obligations will be met. Evidence from studies of social capital in organizations suggests that communities with high levels of social capital are more likely to achieve their goals, among other positive benefits

(Frank et al. 2004; Fukumaya 1995), while those lacking capital may flounder in their efforts (Finnigan and Daly 2017).

Networked Improvement Communities: A Sustainable Approach?

In recent years, NICs are increasingly being formed as a strategic way to address the challenges of scaling educational reforms. NICs are a promising approach to sustaining improvement work since they foster the development of social ties between stakeholders and create structures that support the learning and teaching of a reform (Bryk et al. 2015). A defining goal of NICs is the development of collective knowledge around complex problems and potential solutions (Bryk et al. 2015). Such knowledge is developed through the continuous engagement of district stakeholders, researchers, and program developers in a process of ongoing feedback that creates the organizational learning necessary to facilitate contextually sensitive, locally-led reform efforts (Chambers, Glasgow, and Stange 2013; Hannan et al. 2015; Redding, Cannata, and Miller 2018). When organized within a NIC, individual schools learn both from their own experiences and from the experiences of other schools working on similar problems of practice; thus, systematically pooling individual insights into a collective knowledge base (Bryk et al. 2015).

There are five critical domains that must be attended to when initiating 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, Bryk, Dolle, Gomez, LeMahieu, et al. 2017). These domains capture the requirements for developing a NIC's technical core, capable of promoting organizational sustainability. In establishing the NIC examined in this study, program developers and researchers created an organizational infrastructure that align with the tenants of Russell et al.'s

(2017) model, including building school and district leadership teams that used improvement practices, establishing norms fostering knowledge transfer, and promoting teacher-ownership of the reform efforts reform (Bryk et al. 2015). Specifically, the NIC in our study focused on teacher-leaders to overcome some of the challenges to sustainability stemming from staff turnover (Cannata, Cohen-Vogel, and Sorum 2017). In addition to bringing together researchers and practitioners, the NIC in our study also brought together school and district practitioners, two stakeholder groups that have distinct perspectives on the work of school improvement, but who do not frequently connect to talk about this work (Daly and Finnigan 2011).

Social Networks in School Reform

In this paper, we argue that a way to more deeply understand the sustainability of NICs is through the use of social network analysis, which can shed light on the flow and concentration of information throughout large networks over time, inclusive of a wide and varied range of structures (Daly 2012; Penuel et al. 2012). Social network theory suggests that social networks shape how individuals understand educational reforms, respond to improvement efforts, and access resources (Daly 2010). Social network theory draws attention to the structure of the network, which includes density, centrality, subgroups, and boundary spanners, as well as the number of ties between individuals, as well as their direction (Borgatti and Ofem 2010). The evolution of these features of social networks over time, especially after the gradual release of external support, can help explain the ability of networks to solve long-term problems in teacher practices and professional development, as well as the diffusion of ideas among network members over time.

Research in education has found that social networks shape teacher learning and enactment of school reform. 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 and Russell 2008; Daly and Finnigan 2011). The degree of network density, the centrality of key network stakeholders, the direction of ties and the proportion of reciprocated ties are important as they shape how relational structures can support or constrain improvement efforts (Daly and Finnigan 2011; Finnigan and Daly 2012). Further, network subgroups are often present and boundary spanners play a critical role in spreading information across subgroups within a network (Penuel, Frank, and Krause 2010).

A handful of studies use social network theory and methods to examine the quality and quantity of interpersonal ties between teachers that develop through networked conditions such as professional learning communities and teacher collaboration initiatives. For example, Coburn, Mata, and Choi (2013) find that district policies, resources, and supports influence teacher networks by shaping the tie-formation process, concluding that "teachers' social networks are more amenable to outside influence than previously thought" (Coburn et al. 2013:331). Other studies examine changes in characteristics of teacher networks over time (Spillane and Shirrell 2017; Daly and Finnigan 2010, 2011; Bridwell-Mitchell and Cooc 2016). For instance, Spillane and Shirrell (2017) use social network analysis to examine four years of survey data measuring ties between teachers' collegial and instructional advice networks, finding that work-related ties between school staff dissolve at high rates over time.

Moreover, literature on school reform finds both networks and organizational infrastructure, such as resources and structures, to be key components of reform sustainability (Hopkins and Woulfin 2015; LeMahieu et al. 2017). In addition to sustaining the reform, studies on networks also observe how organizational infrastructure supports the network by providing

structures and resources to maintain and build network ties (Spillane and Shirrell 2017). To the extent that organizational infrastructure and networks are interrelated, an examination of network sustainability requires an examination of the network itself as well as the organizational infrastructure supporting the network.

Social network theory is particularly relevant in the context of NICs, given the mobilization of different stakeholders around shared problems of practice. In this paper, we examine the organizational infrastructure that was maintained by the district and the ways in which it preserved the network structure and processes, thereby helping sustain the NIC.

Research Context

Data for this study come from a seven-year research-practice partnership within a large, urban school district in a southwestern state[1]. We use data from seven participating high schools in the district. The schools enroll between 700 – 1800 students, with an average enrollment of 1500. The percentage of low-income students ranges from about 40 – 90 percent. The purpose of the larger project was to create, scale, and sustain a contextually-specific student ownership and responsibility (SOAR) reform. Three *innovation schools* (Desert Grove, Forest Glen, and Valley) piloted and refined the innovation before it was spread to four additional *scale out schools* (Falls Creek, Woodside, Hillview, and Rolling Plains). The implementation of SOAR varied across schools based on each schools' specific needs, although the core design consisted of teaching students about growth mindset, grade monitoring, goal-setting, and problem-solving.

[1] By the 2016-2017 school year, the district had an enrollment of over 85,000 students across 140 schools, of which 20 are high schools. Approximately 60 percent of the district's enrollment is Hispanic, 20 percent African American, 10 percent White, and 2 percent Asian.

The basis for the SOAR innovation came from research that examined what distinguished higher and lower performing schools in the district (M. A. Cannata, Smith, and Taylor Haynes 2017). A district design team composed of district officials, school officials, teacher-leaders, researchers, and program developers, designed the initial SOAR innovation based on this research. In addition to members of the district team, the network included members of each schools' design team, which was comprised of several teachers and other school staff who either volunteered to participate in the reform efforts or who were nominated by his or her administrator for the work. Teacher-leaders represented a range of content areas, including librarians and other school support staff. Teachers also tended to be midcareer or veteran teachers, with few novice teachers involved on their school's team. While district team members oversaw the design, rapid prototyping, progress monitoring, data collection, and refinement of the innovation designs, school team members worked closely with the district team to adapt, test, and implement the innovation in their schools. Some team-members served on both the school and district teams as liaisons. Finally, the district named an official district coordinator to liaise between the district and school leaders and the external partners and helped to organize logistics (M. Cannata et al. 2017).

Participants in the network evolved over time, beginning with the district team during the 2013-2014 school year and adding more members from the innovation schools before the 2014-2015 school year and scale out schools before the 2015-2016 school year. In spring 2016, the network consisted of the district coordinator, seven school-based teams of around six people each and the district team including teacher-leaders from each of the participating schools, two researchers, three program developers, the district liaison, and four central office leaders.

Researchers and program developers were intentional in developing an organizational infrastructure designed to sustain the network. First, researchers facilitated the use of a continuous improvement approach called Plan-Do-Study-Act (PDSA) (Cohen-Vogel et al. 2015, 2016). School team members used these iterative cycles to test, refine, and adapt components of the reform in their own school contexts. Second, researchers and program developers facilitated quarterly network meetings held at the district central office. These meetings occurred three to four times per year, with a goal of facilitating cross-school collaboration and training school team members on components of the reform. Meetings were attended by teachers on the school teams and administrators and central office staff on the district team. These meetings also provided supported work time for school team members to plan and complete work related to the PDSA cycles. Program developers and researchers led school teams through a variety of tasks, such as discussing best practices and challenges to leading the reform in their respective schools, completing reflection activities, sharing innovative or successful practices across schools, and training new school-based members. During the 2015-2016 school year, responsibility for developing and leading meeting sessions was gradually transitioned to a central office administrator and school team leaders from the three innovation schools. Summer 2016 was considered the official end of the partnership with the external organizations, including the researchers and program developers. This is the date at which the formal structures of external support for SOAR were withdrawn. However, there were a few interactions between the researchers and the district team in 2016-2017, including for data collection.

Data and Methods

To describe how the network was sustained, we employ a mixed methods design (Tashakkori and Teddlie 2010). We use two data sources from the 2015-2016 and 2016-2017 school years: (1) interviews with network leaders conducted in spring 2016 immediately before the withdrawal of external supports, and in fall 2016, immediately after; and (2) two waves of a network survey administered to network members in summer 2016 and spring 2017.

Interview data were collected in two rounds. In March 2016, teams of researchers spent one to two days at each of the seven schools conducting interviews with administrators, school team members, teachers, and students. In the fall of 2016, members of the research team conducted phone interviews with select members of the school and district teams. Each interview lasted between 45 minutes to one hour. The data for this paper comes from interviews with central office leaders, school administrators, and school team members. Though interview guides evolved over time, in general, interviews included questions to learn about participants' experiences, perceptions, and goals regarding the sustainability of the network and the reform work more broadly, including strengths and challenges to the work, interpersonal dynamics, collaboration between school and district team members, and descriptions of network structures. We draw on a total of 77 interviews representing 68 unique participants.

All interviews were recorded, transcribed, and coded using the qualitative data analysis software NVivo. Transcribed interviews were coded as part of the project's framework for innovation design and development. First, the research team created a coding framework for the data collected from fieldwork using a collaborative, iterative process. Individual research team members coded a subset of the transcripts and then met to reconcile differences and identify broader themes in the emergent coding framework. This process was repeated for each wave of

data collection until there was agreement across research team members regarding the comprehensiveness of the framework and the significance of each code (Corbin and Strauss 2014). Thus, the framework consisted of several *a priori* codes in addition to codes that emerged inductively from the data. For each wave of data, researchers, including the authors of this study, wrote analytic memos for each code in the framework. This process consisted of reading all relevant transcript data for the code and synthesizing overarching patterns by school and by stakeholder type using quotes and vignettes to substantiate the themes. Researchers systematically read these memos, identifying patterns in how organizational infrastructure maintained or changed the established network structures. We define organizational infrastructure to mean the organizational structures, systems, and processes established or maintained by the district to sustain or change the SOAR work (Hopkins and Woulfin 2015). We examine additional themes in the data regarding participants' concerns and goals for the long-term success of the network, as well as other emergent themes.

To collect quantitative data on the nature of the network structure, two waves of a network survey were administered. The survey was designed to understand the structure of the social network, including the existence of ties between individuals. For each wave, respondents indicated the other people in the network with whom they had interacted regarding the innovation in the past school year. For each network survey, the target population included all NIC members who were either named by district personnel as being part of the NIC or who were new to the NIC. Although school principals were not official members of the SIDTs in their respective schools, they were still named in the network survey given their oversight over the implementation of SOAR in their school. The survey yielded a 65% response rate in each year (Table 1).

The network survey data is used to compare various network measures between 2016 and 2017. We also observe these comparisons by stakeholder type including teachers, administrators, support staff, and district central office staff. We use the "igraph" and "sna" packages in R to conduct the social network analysis. Measures used in this study include 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 within the network. Centrality is the proportion of reported ties over all possible ties in the network. In-degree centrality measures incoming ties and can be interpreted as prominence in the network. A participant with high in-degree centrality holds importance in the network since the individual is sought out by network members as a source of information. Out-degree centrality measures outgoing ties and can be interpreted as influence or advice-seeking in the network. Participants with high out-degree centrality play a key 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 an 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. To measure change in the social network, we compare these network measures between the end of the 2016 school year (before withdrawal) and the end of the 2017 school year (after withdrawal).

To answer the first research question regarding changes in organizational infrastructure upon the withdrawal of external supports, we use interview data and memos from codes related to sustainability and reform ownership. To answer the second research question regarding the

changes in the network upon withdrawal of external supports, we use interview data to examine changes in the nature of the network and the survey analysis to examine changes to the network structure. Finally, to answer the third research question regarding the implications for network sustainability, we use interview data to examine how changes in the organizational infrastructure, combined with changes to the network structure, created long term supports and challenges for the sustainability of the network.

Findings

Changes to Organizational Infrastructure

The first research question focuses on describing the organizational infrastructure that existed after the withdrawal of external supports. Four features of the organizational infrastructure were present following withdrawal of external support: district allocation of financial resources, the continuation of quarterly network meetings, the leadership of the district coordinator, and the promotion of teacher leadership. While some of these reflect a continuation of what was present in prior years, we observe a notable shift in the network's central hub activities; with modification to the role responsibilities of the district coordinator and a shift in the onus of reform leadership away from district leaders and towards school teams. While the structure of the school teams remained the same, the promotion of teacher leadership at the school levels helped develop high levels of ownership among network members. We describe each element of the organizational infrastructure in turn.

Financial resources. When external support was withdrawn, there was some change in the financial resources available to the network. District leaders continued to offer some endorsement of this improvement work, evidenced by the allocation of resources for network

meetings and staff time and their openness to implement SOAR alongside other mandated district programs. The district maintained funding for the network meetings, covering the cost of substitute teachers during day-long training as well as a stipend for the district coordinator. Further, participating schools continued to pay for the direct costs of the innovation tools, though funding for the network hub activities of documenting learning, developing training activities, and sharing learning—functions previously served by the program developers—was discontinued.

Network meetings. Consequently, the structure of the meetings shifted from years prior. When external program developers led the meetings, the focus was on training school and district stakeholders on the components of the SOAR innovation and the use of PDSA, among other topics, and having school teams share the successes and failures of the practices they were developing. Although some planning time was set aside for school teams, they also participated in small and full group activities designed to build relationships and foster collaboration throughout the network. When the district led these meetings, the bulk of the time was allocated for school-based planning. Participants reported an appreciation for this shift in focus. One member at Forest Glen reported "[The meetings were] a little less structured…There was more time – like planning time with your team available to us, which was something that we really liked." This change was made to allow schools more time to work on designing, implementing, and testing reform elements in their respective schools.

Additionally, participants were given fewer opportunities for sharing their learning across schools. In prior network meetings, program developers facilitated deliberate cross-school sharing through group activities and paired interactions. While a number of school leaders still reported having time during the network meetings to share activities being implemented, there was less

collective effort to work through challenges facing individual schools compared to prior network meetings. Furthermore, compared to previous years where the process of cross-school sharing was used as a tool to create greater coherence in SOAR, there was less of an emphasis on maintaining a common district design after external supports were withdrawn .

District coordinator. While the central role of the district coordinator in the network was preserved, without the support of external partners, the district coordinators' role in the network changed. The district coordinator was now solely responsible for planning network meetings and coordinating SOAR implementation across the innovation and scale out schools. The coordinating role also included working with other district personnel or school principals "behind the curtain" to ensure the continued implementation of SOAR. The district coordinator elaborated how the change in priorities changed the way he leads SOAR in the district:

> I mean, our role at the district right now is just to make sure that the campuses are both empowered to do their work and that there's no obstacles being put in their way. We have quite a few new district initiatives that have been implemented this year that have really made it hard for campuses to prioritize…and so you know, a campus can't have 15 different foci or else they're not focused on anything. And so it's really kind of helped us say, let's try to keep the minimum down to like five foci or less. And one of those at our SOAR campuses is going to be SOAR.

The final shift in the district coordinators' role relates to the way in which materials and other resources were shared across school teams. In the early years of development and implementation, school team members expressed strong support and interest in cross-school collaboration, often emailing materials they had developed or setting up meetings to discuss SOAR implementation. For instance, a participant at Valley recalls receiving a request from Woodside for materials and a SIDT member from Forest Glen describes sending a member of their school team to visit a scale out school to "field questions as well as give a summary of what

we're done". Such practices necessitated social connections with members across schools—connections that were likely forged during network meetings.

When external support was withdrawn, there was less emphasis from external sources (i.e. researchers and program developers) to align school practices with one other. As a result, schools felt less need and pressure to share resources. For instance, a school team member from Desert Grove said, while he believes their school could benefit from looking at "cool stuff that the other schools are doing and making our contributions as well with things that we are doing," that, asking schools to collaborate more is "probably a hard ask". Instead, the district coordinator attempted to standardize the sharing of best practices rather than utilize the cross-school approach that was used before. Any materials that schools wanted to share were sent to one of the district coordinators who would compile and share them with school teams across the district. Yet, while this was described as the approach, several participants described not having any awareness of this resource and no members reported using it. Ultimately, this suggests the role of the district coordinator was maintained, but the change in role responsibilities did not result in the continued transfer of learning across the district.

Teacher leadership. There was a notable shift in ownership of the reform away from the district and towards individual schools. From the beginning, the reform was designed to place teacher-leaders in a prominent role of co-designing, implementing, and leading reform efforts and structures promoting teacher-leadership were a key piece of organizational infrastructure used to develop high levels of ownership among network members. District and school administrators allowed school teams to operate fairly autonomously when implementing reform elements, giving them a large degree of latitude when leading the initiative both before and after the withdrawal of supports. This empowerment and emphasis on teacher leadership increased in

the year following withdrawal. For instance, a district team member at Desert Grove reported that the district gave the team freedom to design and implement the reform as they saw fit, saying the district had been "really open about letting us do what we want and they're backing off…We're given the freedom to do what we want to do and how we want to do it". Similarly, the district coordinator described the high degree of decision-making afforded to school teams in the following fall, "I mean, our [school teams] … are making decisions and doing things with campus administration approval but not participation, you know, from the principals or assistant principals or the campus administration team actively doing that work." Following withdrawal, school teams were given greater ownership over the initiative and were empowered by district leaders and school administrators take charge of the SOAR at their respective sites.

Changes in the Nature of the Network

Our second research question focuses on changes in network interactions and structure in the year following withdrawal of external supports. First, we describe changes in the network interactions using our qualitative data. Next, we provide quantitative evidence of these changes using data from the social network surveys.

Network interactions.

Lack of common vision. The withdrawal of supports muddled clarity around who would provide oversight over the initiative, creating uncertainty in the vision for the future of SOAR in the district. Contributing to this issue was the turnover of a district leader who had been a chief source of support. His turnover brought a new dynamic in the network, where top district leaders were less involved in SOAR's ongoing development and implementation. Without top district leadership promoting SOAR, a district team member expressed concern that the work may be sidelined by the district office "downtown" because the network's district coordinator was not in

a senior leadership position: “You know, [the network] get[s] two people from downtown and they’re definitely people who have the ability to make change, but mostly they do that by asking people higher on the food chain and getting answers, or directing small amounts of resources here and there.” Furthermore, with only a segment of district high schools having adopted the reform, one district team leader said, “in the district, I think it’s perceived right now as kind of a boutiquey thing.” This suggests a perception of SOAR as a non-central part of the new district vision.

Furthermore, the shift in ownership towards schools resulted in greater demand for accountability and support from leadership. A school team member from Valley described a greater need for school-level accountability even prior to withdrawal of support, because “it’s kind of like nobody’s really in charge, so nobody—in my opinion, I feel like nobody’s really in charge of the group”. Since network members were self-led, without clear guidance, it wasn’t always certain to whom the team was accountable to.

Fewer common reform practices. In shifting away from a common district vision for the reform and instead towards individual schools implementing the reform per their needs, less emphasis was placed on common reform elements and cross-network sharing. A district team member at Desert Grove explained how things changed in the fall following withdrawal of external supports, saying there was “not so much pushing forward on ‘here is a vision that we want people to bend towards or align themselves with’… I do feel like there is…a little bit less of the drumbeat of ‘where are you?’ and ‘how are things going?’ With less push from the district on a common district vision of the reform, school stakeholders had greater self-determination in customizing SOAR to their school context. However, as SOAR practices become more distinct across schools, school teams were less able to adapt practices from one another. In other words,

while connections between school team leaders across schools persisted within the network, the degree to which these social connections could be leveraged to share learning was likely diminished.

Network structure. To complement our qualitative data and to further understand how the network structure changed between the year before and after external supports were withdrawn, we compare network measures across these two points in time. Table 2 provides information on the number of times members had, average centrality of each member, proportion of reciprocal ties, and overall network density. In general, comparing network structure between the years provides evidence of a shrinking network. Before withdrawal of external supports, participants had an average of 3.94 ties within their school and an additional 5.86 outside of their school. In the following year, the average number of within-school ties shrank to 3.37 and outside-school ties shrank to 4.94. As the size of the network decreased, the density also decreases from 0.13 to 0.10. The other network measures also indicate a shrinking network. In-degree and out-degree centrality dropped, as did reciprocity. The decrease in these measures appears to be driven by fewer incoming and outgoing connections between the remaining network members as well as a decrease in the number of highly central members, most of whom were external partners no longer formally involved with the network. Overall, these results suggest that the network did persist, but with fewer connections between network members, both within and across schools.

The network graphs in Figure 1 further illustrate this point. Panel (a) of Figure 1 shows the network graph before withdrawal of support. Panel (b) shows the network graph in the second year when external supports were withdrawn. To highlight the importance of certain stakeholders in the network, the area of each node is weighted by the number of reported

interactions. We draw out three key features across these two network graphs. First, the network is less dense with fewer overall interactions between stakeholders in the second year. Second, the before and after withdrawal graphs each depict a central role of the district central office staff. Yet, before withdrawal, their key role was overshadowed, in part, by a central role played by the external partners. After withdrawal, three program developers were no longer engaged with the district and two researchers remained involved, but had a more minor role in the network. In addition, a district leader who had demonstrated a high degree of support for the improvement process had left the district. Third, the most active network members in the year before withdrawal spanned all roles in the improvement work and their schools. After withdrawal, fewer school-based participants appear to have a significant number of interactions with stakeholders within their school and elsewhere in the district. Instead, the dominant pattern was that ties were directed towards the district leaders.

To further illustrate this final point, we create network graphs in Figure 2, excluding district stakeholders and external partners. In both years, a significant share of interactions were directed towards non-school-based members of the NIC, although the graphs suggest that there were more cross-school interactions before withdrawal compared to after withdrawal. While there was still a degree of cross-school interaction, it was greatly diminished compared to a much denser network before withdrawal.

Next, as shown in Table 3, we consider network measures based on individuals' role in the NIC, again comparing differences before and after the withdrawal of external support. The most notable finding for the district role is in terms of the relative consistency for the network measures across these two points in time. The in-degree centrality was consistent while out-degree centrality dropped from 0.50 to 0.42. Betweenness centrality increased from 0.07 to 0.12.

The number of cross-organization ties decreased from 38.33 to 27.5, again reflecting the decrease in the overall size of the network. While teachers had a similar number of ties after withdrawal of support, administrators had more ties, particularly outside of their school, increasing from 1.33 to 4.44. The two external stakeholders who remained involved reported fewer ties, although they did still have the second highest in-degree centrality of all role groups in the district, likely the result of ongoing presentations during network meetings.

Overall, the social network analysis demonstrates the ongoing importance of the district coordinators in sustaining the network. At the same time, it is notable that, as the overall size and density of the network decreased, some, but not all cross-organization ties were maintained among innovation and scale out school members.

Implications for Sustainability of Network

The third research question focuses on the implications to sustaining the innovation due to changes in the network. To understand how changes in the organizational infrastructure and the network influenced the sustainability of the network, we examine the ways in which this infrastructure served as a countervailing force to three main challenges to sustainability identified above in the literature—staff turnover, policy changes, reform alignment (Datnow 2005; Sindelar et al. 2006). Though the district continued its endorsement of the SOAR reform and maintained core network structures, the emphasis on teacher leadership and local ownership of the reform raised concerns for the ongoing sustainability of the work.

Strengths and challenges of relying on teacher leadership. While relying on teacher leadership contributed to sustaining the network and reform efforts, it also presented a challenge to network sustainability in the form of burnout. The high levels of ownership led teacher leaders to remain committed to sustaining the effort and to feel agency to take steps towards sustaining

network supports throughout the year. School team members were motivated to lead the work as needed in their respective schools. In a response typical of many school team members, one district team member at Desert Grove explained the variety of tasks he took on to sustain reform efforts, explaining, “I helped organize the new teacher mentoring… I’ve been doing some of the planning kind of work…I’m helping to organize that by communicating with the other team members. I’ve been doing some of the work to talk with administration…” As this quote suggests, the empowerment of teacher leaders positioned them to maintain network activities such as coordination and intra-team communication.

However, given the prevalence of and reliance on teacher-leaders in the network, the burnout and turnover of these stakeholders was concerning for the long-term sustainability of the network. Teachers described feeling as if they had “reached…capacity,” articulating a need for more administrator, or “non-teacher level,” support to assist them in their work. The strain on teacher-led teams also influenced their turnover, hindering the sustainability of the network. A school team member from Desert Grove also reiterated how much the network depends on the school team members, saying that if “multiple of us leaves…I don’t know how long it would last without the five of us pushing”. A district team member at Falls Creek added that “I just know if I were to leave the committee, there are four people who wouldn't even come back to any more of the meetings”. While the tight-knit nature of the school teams and their commitment to this work is a benefit to the sustainability of the network, it also poses a potential challenge to future sustainability when the sustainability of the team depends on members staying on board.

State or district policy changes. Policy changes were another factor shaping the sustainability of educational reforms. In anticipation of this challenge, network members were trained in how to conduct PDSA to continually make principled refinements to the SOAR

innovation that remained responsive to the shared design principals and changing policy conditions. Yet, after the withdrawal of external support, less attention was dedicated to the components of the SOAR innovation and the use of PDSA in network meetings, resulting in a diminished ability to incorporate SOAR into the new district administration's priorities. At the same time, the district coordinator offered little clarity over the vision for the future of SOAR in the district. Consequently, SOAR was perceived as one among several programs competing for attention by school administrators regarding what would be adopted in a given school year.

Lack of innovation alignment with school vision. A final challenge to sustainability denoted in previous reform efforts is the lack of alignment with school structures. As noted above, the empowerment of teacher-leaders created opportunities for the development of a design that aligned with school structures. At the school-level, the increased focus on using teacher-leaders to make school-level improvements presented a challenge for sustainability, as the continuation of the reform required greater support from school principals as the building leaders. Network members emphasized how shifts in principal goals altered the amount of resources, such as planning time funding, allocated to the initiative, as well as leadership support. One district team member explained that the sustainability of the network "really boils down to who is running that school and who's controlling the resources, and their level of buy-in and their level of understanding." She added that there is variation in the potential for sustainability of the reform across schools depending on the support the reform receives from the principal:

> ...unfortunately, I've been in this district long enough. There are a couple of principals that I know of where they don't understand this work. It's sad to say this, but they're more of a dictator in their roles. And so a dictator is not – this won't be sustained under a dictator.

From another principal's perspective, sustainability was a question of whether the reform aligned with the principal's vision. An administrator at Forest Glen asserted that the principal is the

"rudder" of the "ship" and "wherever their eyes are, that's where the ship is going". Both teacher-leaders and principals acknowledged that the reform must fit in with the vision of the school leaders. Ultimately, the lack of long-term vision for SOAR at the district level created greater reliance on principals to provide support and resources to school teams. The potential for shifts in priorities at the school-level created uncertainty amongst teacher-leaders about the future of the network and reform.

Discussion

There is evidence in the literature on school improvement that external reforms can be sustained when their adoption leads to deep cultural change within the educational organization (Fullan 2016). Coburn (2003) cautions that even when individual schools achieve this deep-seated change, shifting district priorities and staff turnover can undermine the sustainability of improvement efforts over time. NICs attempt to stave off some of these challenges by creating a system of improvement within districts (Russell, Bryk, Dolle, Gomez, Lemahieu, et al. 2017). In this paper, we have examined a NIC that leveraged strong reform ownership among teacher leaders and the district coordinator to sustain elements of the network once external support was withdrawn.

In general, we found a contraction in the network with fewer cross-school ties, and a greater reliance on the district coordinator to transfer knowledge between schools instead of direct, school-school contacts. These findings are consistent with qualitative evidence that finds that schools had greater autonomy to sustain the reform at each school site, with most schools relying on the district coordinator to bring schools together during the network meetings to work *alongside* rather than *jointly with* one another. The NIC relied on a district coordinator to manage

resources developed by school teams, which heightened the coordinators' central role in the network, but diminished cross-school sharing as a mechanism for the transfer knowledge between current and incoming network members. This finding affirms work by Sanders (2012) who identified the central role played by district coordinators in facilitating the information transfer and relationship building during a successfully sustained reform effort.

Previous research has identified supportive networks and the presence of strong teacher relationships as important for the sustainability of external reform (Coburn et al. 2012; Dresner and Worley 2006). In our study, the empowerment of teacher-leaders was seen as a key piece of infrastructure in the successful sustainability of SOAR after external support was withdrawn. To a certain degree, the reliance on teacher-leaders helped to withstand turnover among district and school leaders who had previously supported SOAR. Yet, concerns remained regarding the burnout of teacher-leaders, teacher-leader turnover, and conflict with principals over what was best to implement within their schools. Turnover challenged their work by forcing team members to renegotiate resources, re-train teachers, and re-build relationships with administrators or other teachers. In many instances, these problems overburdened teacher-leaders, elevating the risk for their turnover.

Another key facet of teacher leadership was the self-determination to customize SOAR to the local needs of students and teachers. Yet, with fewer opportunities for cross-school sharing, what was implemented at each school began to depart in more noticeable ways. With less coherence for the elements of SOAR, it remained difficult to spread SOAR to new schools and participants were concerned that it would be easier for the district to abandon a program that is increasingly being implemented as a site-based reform. Less commonality in the design of SOAR across schools also left less opportunity to learn across school teams, again, decreasing

the need for the district to support network meetings. This finding affirms previous work indicating that collective knowledge-building requires both the concerted development of processes and structures for sharing information across schools while also maintaining focus on a shared problem of practice (Glazer & Peurach, 2015; Peurach & Glazer, 2016; Redding et al., 2018).

This study is not without its limitations. First, we experienced a lower response rate than is preferred for both waves of our social network survey and turnover amongst the school teams. As a result, we do not have a matched sample of network members before and after external support withdrawal. Second, as data collection ceased by summer 2017, we have only one years' worth of data following the removal of external support. Hence, our study cannot speak to the sustainability of a network beyond one year.

Compared to previous reform approaches, a chief corrective of NICs is to see educational issues as a product of the system (Bryk et al. 2015). Reforms that are responsive to this system orientation must incorporate district processes that align individual efforts towards efficacious solutions. The continuous engagement of multiple stakeholders in a process of ongoing feedback can create organizational learning necessary sustained for improvement of school systems (Chambers et al. 2013). A renewed emphasis has been placed on better understanding the improvement infrastructure itself, an infrastructure inclusive of the practices network members are implementing in schools as well as the network tools that enable this work to occur in an improvement community (Hopkins and Woulfin 2015; Peurach 2016). This study shows that infrastructure developed as part of this NIC can be sustained once external support has been withdrawn, but is replete with challenges.

In our study, the network did not seem well-poised to survive past the turnover of the teacher-leaders or past long-term changes in district and school policies despite the fact that key network structures such as the network meetings, the faciliatory role of the district coordinator, and the focus on teacher-leadership were maintained. Our results point to an emergent tension in improvement communities between the sustainability of the network infrastructure versus the problem with which the network was designed to improve (i.e., SOAR). The withdrawal of external supports was associated with a less centralized "hub" that created some opportunity for continued collaboration, but, when occurring alongside increased self-determination at the school level, was linked with less consistency in the practices adopted across participating schools in the district. As reform practices diverged and school teams became more internally-focused, the overall structures intended to sustain the network such as cross-school sharing and collaborative development, dwindled.

How then might networks sustain? Future work may consider examining reforms which, when scaled, focus on scaling the understanding of the theory of action behind reform practices rather than the reform practices themselves. Preserving a common networked focus on the theory of action may better facilitate the maintenance of key network infrastructure but allow for localized adaptation of practices (Hopkins and Woulfin 2015).

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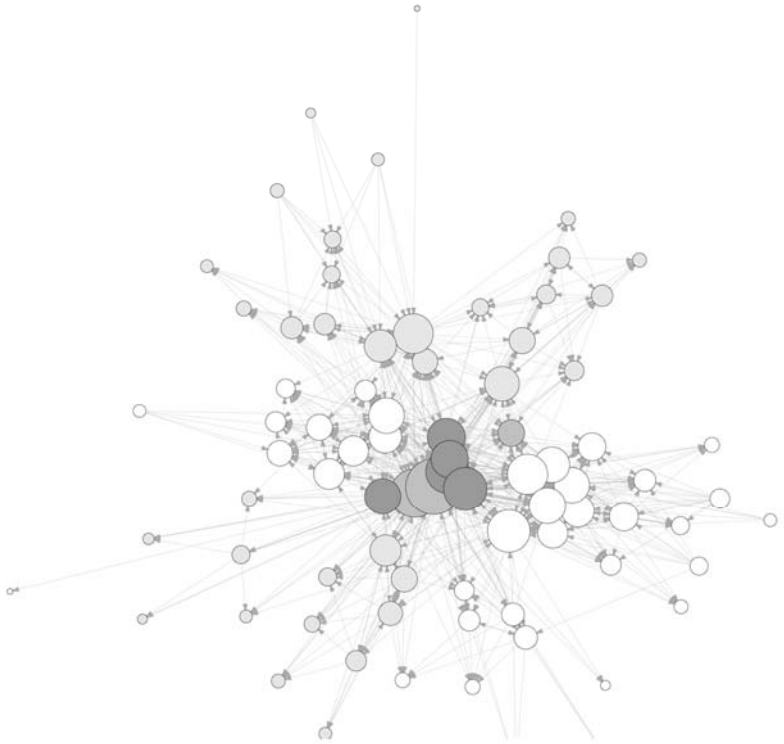
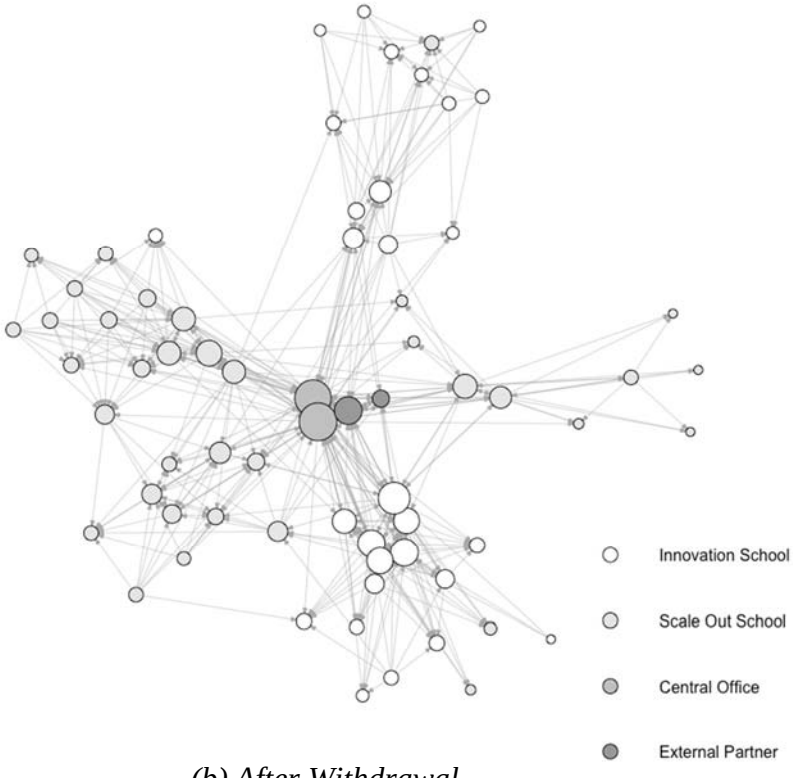
Figures and Tables

Figure 1. Improvement Networks, Before and After Withdrawal of External Support

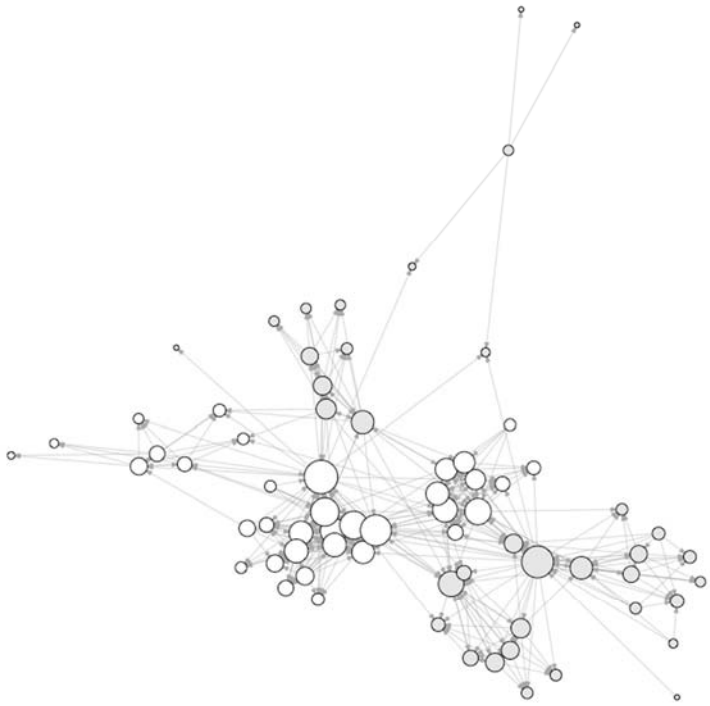


(a) Before Withdrawal

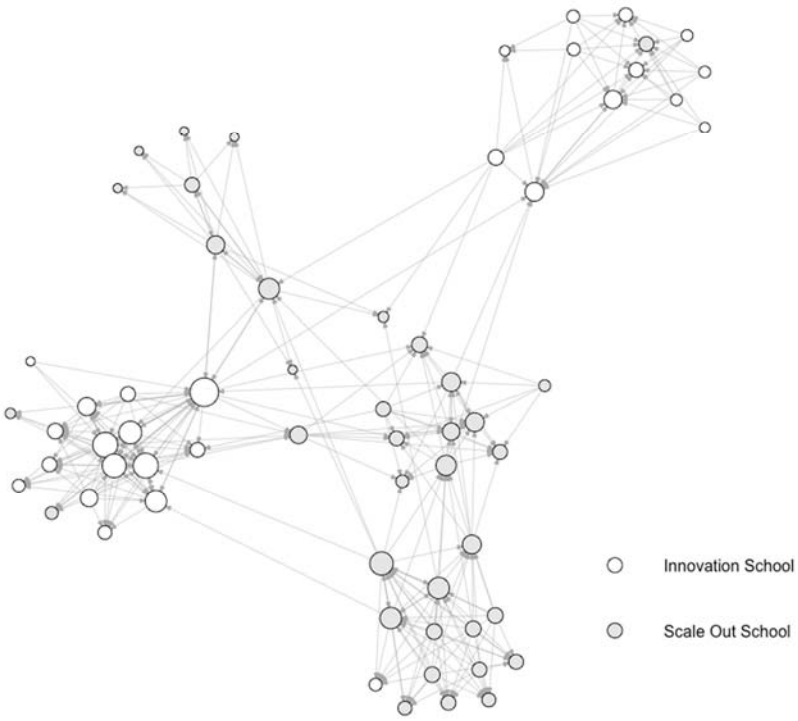


(b) After Withdrawal

Figure 2. Improvement Networks, Before and After Withdrawal of External Support, Without District and External Partners



(a) Before Withdrawal



(b) After Withdrawal

Table 1. Social Network Survey Data Collected in Each Year

	Before Withdrawal	After Withdrawal
Total Target Sample	80	65
Members named on the survey	72	65
Additional stakeholders	8	0
Number of Responses	52	43
Response Rate	65%	65%

Note. All additional stakeholders in the year before withdrawal were teachers new to the school implementation teams who were not named on the survey.

Table 2. Participant Characteristics and Network Structure Over Time

	Before Withdrawal	After Withdrawal
Role in Improvement Work		
School team member	0.76	0.80
District team member	0.14	0.13
District central office staff	0.04	0.04
External auxiliary	0.06	0.04
Role in School		
Teacher	0.73	0.74
Administrator	0.15	0.17
Support staff	0.03	0.02
External stakeholder	0.10	0.07
Network Structure		
Number of ties (within school)	3.94	3.37
Number of ties (outside school)	5.86	4.94
In-degree centrality	0.13	0.10
Out-degree centrality	0.12	0.10
Network density	0.13	0.10
Reciprocity	0.44	0.29
N	80	65

Note: While external stakeholders (researchers and program developers) were no longer formally involved in the work after the withdrawal of the grant supports, members of the research team still interacted with network members to conduct research activities in the year after withdrawal.

Table 3. Role in Improvement Work and Network Structure Over Time

	Teacher		Administrator		Support Staff		District central office		External	
	Before	After	Before	After	Before	After	Before	After	Before	After
In-degree centrality	0.11	0.08	0.13	0.08	0.11	0	0.31	0.34	0.27	0.20
Out-degree centrality	0.10	0.11	0.05	0.11	0.14	0.07	0.50	0.42	0.34	0.10
Betweenness centrality	0.004	0.006	0.003	0.008	0.002	0	0.07	0.12	0.02	0.01
Within-organization ties	4.4	3.68	2.5	3.22	9	2	1.33	1	1.6	1
Cross-organization ties	3.57	3.95	1.33	4.44	2.5	3	38.33	27.5	25.2	5.5
N	58	40	12	9	2	1	3	2	5	2

Note: “Before” refers to the year before withdrawal and “After” refers to the year after withdrawal.