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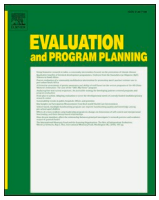

Assessing organizational capacity for diffusion: A school-based social network analysis case study

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ABSTRACT

The purposeful design of social networks is increasingly recognized as a fundamental organizational improvement strategy. In the PK-12 education sector, school-based teacher collaboration is the primary vehicle through which educators are able to gain access to essential social capital, and through which leaders promulgate diffusion of innovation and continuous organizational learning. In partnership with school administrators, the authors undertook an evaluation to examine the size, structure, and composition of school-based networks. Social network analysis (SNA) was used to measure and visualize connections (or lack thereof) of ties between teams and between educators. Isolate and disconnected network actors were revealed through visual inspection of the sociograms. Administrators used findings to reconfigure team membership to enhance teacher ability to give and receive support and collaboratively problem-solve, and to ensure greater capacity for diffusion of instructional innovation and organizational learning. This paper contributes to the field's understanding of how evaluators and organizational leaders can use SNA to measure, visualize, and more purposefully design effective patterns of connection between people through which professional knowledge, support, and innovation will travel.

1. Introduction

The purposeful design of organizational networks and professional collaboration is increasingly recognized as a fundamental organizational improvement strategy. Non-profit groups, multi-national corporations, and governmental agencies across the domains of education, health, environment, and the human services embrace organizational collaboration as a primary vehicle for reaching organizational goals. The purposeful design of teacher collaboration is a predominant reform approach in the PK-12 educational sector (Gajda & Koliba, 2008; Venables, 2018a, 2018b; Woodland, 2016; Yendoll-Hoppey & Dana, 2010). Educator collaboration has been linked to many important organizational imperatives including *teacher efficacy* (Mazur & Woodland, 2019; Woodland & Mazur, 2018); *teacher satisfaction* (Sargent & Hannum, 2005; Vescio, Ross, & Adams, 2008), *teaching practices* (Curry, 2008; Slavit, Kennedy, & Lean, 2011; Vescio et al., 2008) and *student achievement* (Egodawatte, McDougall, & Stoilescu, 2011; Goddard, Goddard, & Tschannen-Moran, 2007; Lomos, Hofman, & Bosker, 2011). Underlying the enthusiasm for organizational collaboration is the implicit recognition that individuals are not insular. People, and groups of people within organizations, are embedded within patterns of social interactions; their mutual connections act as conduits for the exchange of ideas and other essential resources, and these resources can advance (or impede) individual and organizational goals (Nahapiet & Ghoshal, 1998). Because sources of knowledge and ideas are understood to lie in the structure of relational ties in which an actor is embedded (Adler & Kwon, 2002, p. 19), an individual's position relative to a larger network may have profound implications both for the actor and for the organizational network as a whole.

Capacity for continuous school-wide instructional improvement is only partly determined by how many educators are "highly qualified"; increasingly it is recognized that instructional improvement is predicated on the extent to which teachers have real-time access to social capital and support from their colleagues (Farley-Ripple & Buttram, 2015). The capacity of the network of professional connections to support the acquisition, flow, and sharing of critical resources between teachers are "a critical way to sustain the work of teaching and learning and ultimately of change" (Daly, 2010, p. 1). Denser networks are associated with resource exchange and complex curricular implementation, while less dense but still cohesive networks of ties provide

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teachers access to important but less complex types of information and resources. A network comprised of isolated individuals and disjointed teacher teams is incapable of supporting the type of instructional innovation and flow of professional knowledge and support required to deliver a consistently equitable and exceptional education to all students, whereas a purposefully designed, cohesive teacher collaboration network has far greater capacity to propagate instructional innovation and problem-solving that enables the attainment of organizational goals. When done by design, teacher collaboration enables equitable access to embedded social capital and fosters the flow of instructional innovation across classrooms.

In this evaluation, the size, structure, and composition of a school-based teacher collaboration network was examined. Evaluation findings were used by school and district leaders to redesign their educator networks in an attempt to promote greater teacher access to social capital, diffusion of instructional innovation, and continuous organizational learning.

1.1. The study and context

The evaluation took place during the 2018–2019 academic year in FC Warren,[1] a school district that used the term professional learning communities (PLCs) to refer to educator collaboration and as a shorthand to indicate groups of teachers brought together in teams to engage in collaborative problem solving around issues of teaching and learning. School leaders strongly believed that teacher access to and participation in a strong professional network is a powerful mechanism for bringing about instructional improvement and student learning. Their efforts to create a cohesive professional learning community was seen as a cost-effective strategy for effective teacher professional development and school improvement.

The FC Warren District has "Rural-Distant" NCES classification, which means that the district is more than five miles but less than or equal to 25 miles from an urbanized area, and that it is more than 2.5 miles but less than or equal to 10 miles from an urban cluster (National Center for Education Statistics, 2021, n.d.). It is comprised of an elementary and a middle school co-housed in one building, and a high school. The overall aim of the evaluation was to enable the new FC Warren superintendent and her nascent leadership team to create greater capacity for teacher collaboration and the improvement of fundamental instructional practices. The district's public theory of action was that *if all teachers collaborate and problem solve about the delivery and effects of fundamental instructional practices, and new knowledge and ideas about effective instruction are shared among all PLCs, then teaching quality will become and remain uniformly high, which will enable all of our students to access a rigorous curriculum and experience meaningful learning.*

The superintendent began her contract with FC Warren in September 2018. She had over a decade of experience as a superintendent in another district where PLCs and high levels of student engagement and achievement were the norm. The superintendent believed it was very important to engage in a needs assessment to ascertain the current capacity of her new district for high quality collaboration—the type of collaboration, that in her words, would "ensure that teachers get support and are talking about student learning and instructional practice in a disciplined way, so that more—and hopefully all students—will be more engaged and have a more equitable and excellent learning experience at FC Warren."

Two principals, the superintendent, the special education director, the curriculum coordinator, and the technology director took primary responsibility for launching the PLC initiative and became identified as the District Leadership Team (DLT). This DLT reached out to the authors of this paper to evaluate the capacity of their teacher networks to support diffusion of instructional innovation.

[1] This is a pseudonym, as are all names used in this paper.

1.1.1. Evaluation focus

The study was designed to examine a school-based teacher collaboration network and assess the extent and ways in which it supported or constrained teacher access to social capital, diffusion of instructional innovation, and continuous organizational learning. We undertook a social network analysis (SNA) approach to systematically understand the size, composition, and structure of the FC Warren teacher collaboration network and to facilitate stakeholder use of the findings in their decision-making. The teacher collaboration network was defined as the face-to-face interactions within and between formally existing (administrator created) teacher teams. Formal teams are crucial to understanding organizational networks' capacity for diffusion of innovation and access to social capital. Although networks of informal relational ties are important (i.e. conversations at lunch or in the staff room), those ties are largely outside the purview of administrator control. The design of school-based, purposefully formed collaborative teacher teams, however, are a primary responsibility of school leaders; effective principals set up, support, resource, and supervise teacher teams with the expectation that collaboration will lead to improvements in instruction. As asserted by the National Policy Board for Educational Administration,

> "Effective educational leaders foster a professional community of teachers and other professional staff to promote each student's academic success and well-being…they establish and sustain a professional culture of engagement and commitment to shared vision, goals, and objectives pertaining to the education of the whole child; high expectations for professional work; ethical and equitable practice; trust and open communication; collaboration, collective efficacy, and continuous individual and organizational learning and improvement" (Standard 7, National Policy Board for Educational Administration, 2015).

In this study, school administrators sought to shed light on the following questions:

1. What is the current size, composition, and structure of the FC Warren teacher collaboration network and in what ways does it engender and/or impede teacher access to social capital, diffusion of instructional innovation, and continuous organizational learning?
2. How might we, the DLT, reconfigure the FC Warren network to better advance teacher access to social capital, diffusion of instructional innovation, and continuous organizational learning?

1.2. Social network theory

A SNA approach was employed to address the evaluation questions. SNA can be used to measure and graphically visualize connections between members of an organization and to determine how network affiliations may support or constrain teacher access to social capital, the promulgation of innovation, and continuous organizational improvement. Social network theory assumes that "an actor's position in a network determines in part the constraints and opportunities that he or she will encounter" (Borgatti, Everett, & Johnson, 2013, p. 1). Moreover, it accepts individuals as interdependent, whereby individual beliefs and behaviors are greatly influenced by their structural position within the network (Deal, Purinton, & Waetjen, 2009). Connections between actors (i.e. teachers and teacher teams) are the conduits through which educators access social capital, i.e. the wide range of resources embedded within a school-based network (e.g. knowledge, ideas, instructional resources, support, etc.)

Freeman (2004) distinguishes four hallmarks of SNA: (1) a focus on structuralism based on ties among actors, (2) the collection and use of empirical data, (3) the use of graphical imagery and visualizations, and (4) it is mathematically based. These hallmarks are predicated on social network theory core assumptions, including an understanding that: (a)

relations between actors matter, i.e. relations can explain behavior and attitudes, (b) networks affect attitudes and behavior through direct and indirect connections, and (c) relations within and between networks are dynamic not static (Knoke & Yang, 2008). SNA is utilized to address educational evaluation questions predicated on social network theory, especially those that are concerned with social capital, organizational learning, and the implementation and sustainability of innovation and reform (Atteberry & Bryk, 2010; Coburn, Choi, & Mata, 2010; Whitcomb, Woodland, & Barry, 2016; Woodland, Barry, & Roohr, 2014). For example, Leana and Pil (2006) investigated how administrative attention to the overall structure of a school's communication network influenced information sharing and the exchange of knowledge among educators. Moolenaar and Sleegers (2010), examined cohesiveness of teacher networks and found that teachers in "dense" instruction-focused networks perceived their working climate to be more innovative than teachers working in schools where few relational ties existed. Coburn et al. (2010) used SNA to mathematically and visually understand the composition and structure of four elementary school networks. Their study revealed that teacher collaboration is strongly influenced by existing organizational norms, structures, and practices, and that "the tie formation process is amenable to policy intervention" (p. 48).

2. Evaluation methods

FC Warren network data was collected through a multistep process. The superintendent and her DLT completed a sociometric inventory through which they identified all FC Warren teachers and the teams they were currently on and with whom. A spreadsheet was created that accurately identified all school personnel by name, the teams of which they were a member, and the number and size of teams for the elementary and middle schools in the district (grades one through eight). From this verified raw data, single-mode and two-mode matrices were produced in ®Excel. Single-mode matrices indicated (1) faculty ties with one another (i.e., faculty that were on teams with one another) and (2) shared membership on teams (i.e., pairs of teams that had joint membership by faculty members). The two-mode matrix indicated faculty membership on teams. In total, the data consisted of 55 teachers participating in 22 possible school-based teams.

Excel matrices were imported into UCINET (Borgatti, Everett, & Freeman, 2002), an SNA software that enabled creation of the teacher network sociograms (maps). Datasets were saved in UCINET, measures of cohesion were calculated, and sociograms were created based on the data for each matrix. The NetDraw function within UCINET was used to create the sociograms, and the size of the nodes and weight of the ties were adjusted to visually display network attributes to lend a clearer representation of team membership and relationships among the educators in the school.

2.1. Network measures

The six network measures of import to this study are defined in Table 1 and described below.

Table 1
Key Network Measures.

Measure	Definition
Size	The number of nodes in a network (i.e., number of teachers)
Density	The number of existing connections between people divided by the number of total possible connections
Connectedness	Proportion of pairs of people who can reach each other through the formal network, even if they are connected through multiple other actors
Isolates	Nodes (people) not connected to any other node and/or component
Component	Set of nodes (i.e., group of teachers) all of whom can access every other node in the group by some path
Average Degree	The average number of connections individual actors (i.e., teachers) have within a whole network

2.1.1. Size

Size refers to the number of nodes or actors that make up a network. In this study, the terms "actor" and "node" are used interchangeably to refer to individuals in the networks (i.e., teachers, administrators, or paraprofessionals). Between network actors there are lines or "ties" that represent some type of connection; in this network, the lines represent connections between actors that result from shared membership on a PLC team.

2.1.2. Density

Density refers to the proportion of ties that exist between people out of the total number of ties possible and can be used as an indicator of social cohesion (i.e., higher density equals more cohesion). Typically, small networks may be more likely to exhibit higher density measures than large ones given that it is more feasible for people to maintain ties within a small group of individuals than within a large one (i.e. A network of 15 people, therefore, can be expected to have a higher density than a network of 150).

2.1.3. Connectedness

Connectedness indicates the proportion of pairs of people who can reach each other through network affiliations and ties. In terms of connectedness, it is rarely possible, efficient, or desired for every actor (teacher) in a network (school) to have direct ties to every other teacher. However, a cohesive constellation of direct and indirect ties will enable knowledge, resources, and innovations to reach all actors in the network.

2.1.4. Isolates

Isolates refer to people who are not connected to another node or to another component of the network. It is important to understand how many and which school staff are disaffiliated with the network and thus without access to the network's social capital resources. Similar to isolates are pendants, those nodes with only one other connection. Isolate and pendant nodes have no or little access to social capital, and they are not positioned to receive or diffuse innovation or enhance organizational learning.

2.1.5. Components

Most networks are made up of components, which are defined as sets of nodes who can all access every other node by some path. In an undirected network such as the one under study here (meaning that ties either exist or they don't – there is no directional property to them), two actors are members of the same component if there is a path connecting them. In theory, networks with many components tend to be less cohesive, while networks with fewer components are more cohesive and support the diffusion of innovation and access to social capital (Borgatti et al., 2013).

2.1.6. Average degree

Average degree indicates the average number of ties that individual actors have within the network (i.e. a measure of how many other teachers or groups each teacher is directly and indirectly connected to). Average degree is a measure of centrality that helps to illuminate how teachers are positioned to give, receive, and broker information exchange in their school's network over time.

3. Findings

3.1. Evaluation question 1

To address the first evaluation question, we used NetDraw in UCINET to produced three graphs from the sociometric data: (1) *a Team Membership Network* indicating faculty members' membership on teams, (2) a

Teacher Ties Network indicating strength of ties between members based on shared team membership, and (3) a *Team Network* indicating strength of ties between teams based on shared faculty membership. Each sociogram illustrates a unique aspect of the FC Warren network, and in each sociogram the nodes include circles depicting individual faculty members (all teachers and administrators) at the school and/or squares depicting the school's different professional teams. Findings for each network are discussed below.

3.1.1. Team membership network

The first sociogram we created to consider the existing school network depicts teachers' membership on the teams within FC Warren (see Fig. 1). We developed this sociogram using the two-mode matrix that presented data on faculty members' team membership. Findings indicate that each faculty member was on an average of 2.2 teams, and each team had an average of 5.3 members. The resulting sociogram consists of 77 nodes representing 55 faculty members depicted by circles, and 55 faculty members depicted by circles, and 22 teams depicted by squares. For teacher nodes (circles), the size of the circle reflects the number of teams for which each educator is a member. The more teams a faculty member is on, the larger the node. Similarly, for the team nodes (squares), the node size is proportional to the number of teachers on a particular team. The more members a team has, the larger the node size. The ties connect the teacher nodes to the team nodes, indicating to which team(s) each individual belongs. The inclusion of these attribute data enable us to see which individuals have more or less access to social capital resources embedded in the network, and which actors are best positioned to broker information and innovation flow throughout the network.

Fig. 1 reveals many small nodes, i.e. there are numerous faculty members who are connected to only one team. Conversely, nodes AE and AF, who are members of 8 and 7 teams, respectively, have the largest sized nodes in the network. Similar analysis of the teams indicates that the Special Ed team has the most membership with 12 faculty members, followed by the ENCORE/Specials and Team Leaders teams, with 11 members each.

The network structure consists of three components: a larger component of faculty members and their team membership and two smaller components of the Grade 2 and Grade 4 teams with their respective members. The smaller components are isolate teams, which means that their members are not formally connected to any other teams of teachers in their school and are isolated from the larger component of the network. In addition to the members of the Grade 2 and Grade 4 teams, 22 of the 55 faculty members (i.e., 40 %) are only members of one team. Furthermore, 12 of these 22 faculty members are members of either the ENCORE/Specials team or the Special Education team. These members not only have limited access to social capital with respect to their ability to meet with colleagues, but they are also part of teams that are not well-integrated within the rest of the network.

There are two individuals within the network who serve as bridges between one of their teams and the larger school network. A bridge is a link between two nodes that, if missing, would cause one component of the network to be disconnected from other components. In this network, if the teachers represented by node P or node I were removed from the network (for example, they moved schools, had an extended absence, or were removed due to restructuring of team membership) or they stopped participating on their teams, at least one of their teams would have no connection to the larger school network (i.e., the Grade 3 team for P and the Grade 1 team for I).

Another finding pertains to the Grade 1 through Grade 4 teams. As discussed above, the Grade 2 and Grade 4 teams are disconnected from the rest of the network, and the Grade 1 and Grade 3 teams are only connected to the broader network via a single bridge. Looking at these teams collectively highlights how the lower grades in the school are not connected with each other and are only tenuously connected to the wider school network. Grades 1–4 comprise half of the grade levels within the school (serving half the study body), yet they are not as connected to the full network as the upper grade-level teams (i.e., Grades 5 through 8).

Despite the fact that every teacher is assigned to at least one team in the network, there are few people who are highly connected (i.e., members of multiple teams) and few teams that have high teacher membership. To further investigate network structure, we calculated measures of cohesion and centrality through UCINET (Table 2). The average degree of this network is 2.1, indicating that, on average, each teacher is formally connected to two other teachers within the school via the formal vertical and horizontal teaming structures. The FC Warren network has a density at 0.040, which means that only 4.0 % of all possible ties exist in the current network. A network with higher density

Table 2
Team Membership Network Measures of Cohesion.

Measure	Result
Average Degree	2.182
Density	.040
Connectedness	.517

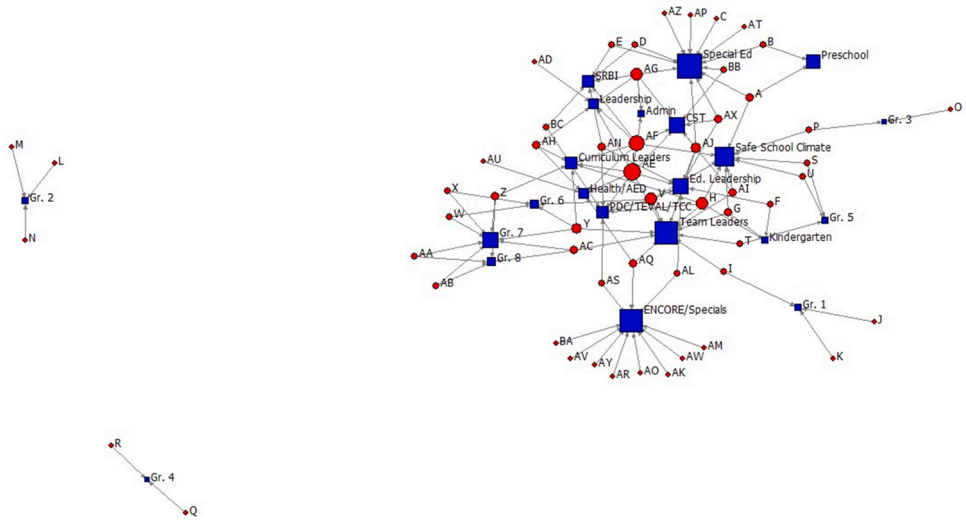

Fig. 1. Team Membership Network.

would have more paths available for sharing information and innovations across the networks. With a connectedness measure of .517, about half of FC Warren teachers cannot reach one another through formal network channels.

3.1.2. Teacher ties network

In addition to considering team membership and connectivity, SNA was used to examine actor to actor connections. These analyses were important to school leaders, as they helped them to identify which staff members may need more support and which members may be best positioned to provide such support and foster further engagement. To conduct this analysis, we removed the teams from the matrix and reformatted the data to include only direct ties between staff members. Weights were assigned to the ties to indicate how many teams each pair of teachers are a member of; the thicker the tie, the more teams the two actors are on together (see Fig. 2).

The FC Warren Teacher Ties Network shown in Fig. 2 reveals two clusters of actors that are more tightly connected via shared membership on teams: cluster one includes nodes W, X, Y, Z, AA, AB, and AC; and cluster two includes nodes D, E, G, H, V, Y, AE, AF, AG, AH, AI, AJ, AN, AX, BB, and BC, with Y connecting these two clusters. A more detailed view of clusters one and two is shown in Fig. 3.

As can been seen through visual inspection of the Teacher Tie Network, other sets of teachers have ties throughout the network, however, they are not as strong as clusters one and two.

3.1.3. Team ties network

For this analysis we examined ties between teams, sans teacher nodes. The resulting sociogram shown in Fig. 4 represents connections between teams. Lines represent the number of people on each dyad of teams. Teams with higher numbers of members serving on each dyad of teams are represented by thicker lines and teams with fewer members serving on both teams are connected by thinner lines. There are 15 dyads of teams sharing three members, 19 dyads of teams with two shared team members, and 39 dyads of teams that have one shared member.

The greatest number of formal ties exist between (1) the Team Leaders and Safe School Climate teams, (2) the Special Ed and CST teams, and (3) the Grade 7 and Grade 8 teams, with four of the same members respectively serving on each team. The ties exhibited between these sets of teams suggest that information and ideas can more directly transfer between the teams in each dyad. A visual inspection of the sociogram in Fig. 4 reveals that Grades 2 and 4 are not connected to the school's network. Additionally, Grades 1 and 3 are in a vulnerable position within the network. They could become disconnected from the school's network if the one person on each of the grade level teams were to leave the team, or if that person is unable/unwilling to act as a communication bridge. Grades 1 and 3 teams would then become isolates like Grades 2 & 4. Risk of isolation can be addressed by building purposeful redundancies and overlap in team membership in an organization's communication network. The more unique ties there are connecting individuals and teams to the rest of the network, the more likely they are to give and receive support and the more likely innovations can flow throughout the network.

Because it is theorized that flow of information and diffusion of innovation are more likely to occur between nodes that have a shorter versus long distance between them, it can be useful to determine and assess geodesic distance (the shortest path between two nodes) across a network. For example, the geodesic distance between Grade 6 and 7 teams is one (a short distance for information to flow between nodes), whereas the geodesic distance between the SRBI team and the Grade 7 team is three, indicating a longer path along which information must flow. The longer the path, the greater potential there is for information to not reach its intended recipient team members and vice versa.

3.2. Evaluation question 2

All SNA visualizations and analyses were shared and discussed with the Superintendent and her District Leadership Team in a series of face-to-face meetings. In our role as facilitators of the DLT meetings, we utilized protocols to increase meaning-making and use of findings, including the "I Notice/I Wonder" protocol (Venables, 2018a, 2018b). The DLT examined the findings to look for instances in which nodes (teachers) were isolated or at risk of isolation from the broader network, or were bridges serving as the only link between their team members and the wider school network. The DLT considered node attributes, such as how many teams each individual participated in and the number of members on each team, as well as how strongly individuals and teams were connected to one another. The DLT thoughtfully interpreted the sociograms seeking to determine which of their teachers could access social capital, how easily information could flow through their school's network, where diffusion may be obstructed in their network, which teachers may hold more influence within the network, and which educators may receive more or less formal support from their colleagues based on their position within the network.

To strengthen their network, the DLT used the evaluation findings to make a series of evidence-based decisions about how to increase teacher

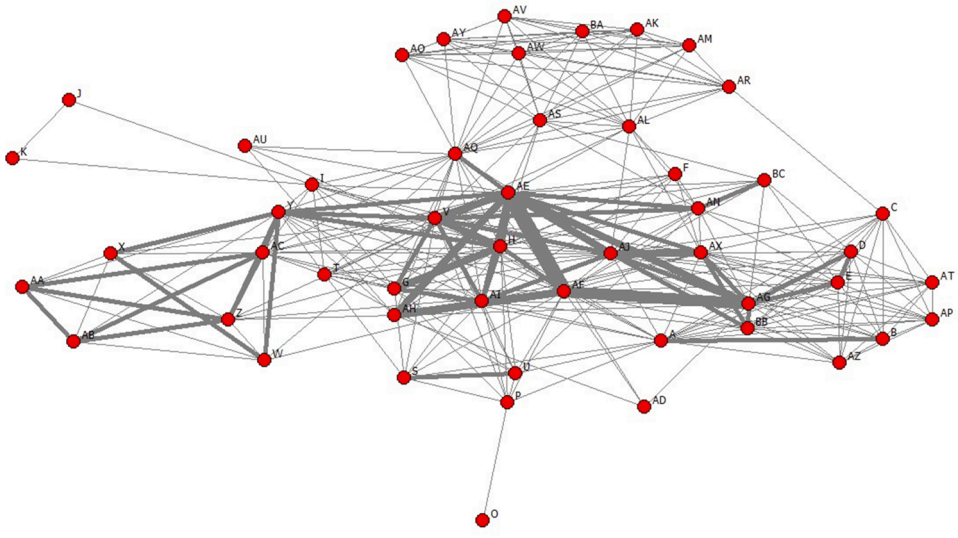

Fig. 2. Teacher Ties Network.

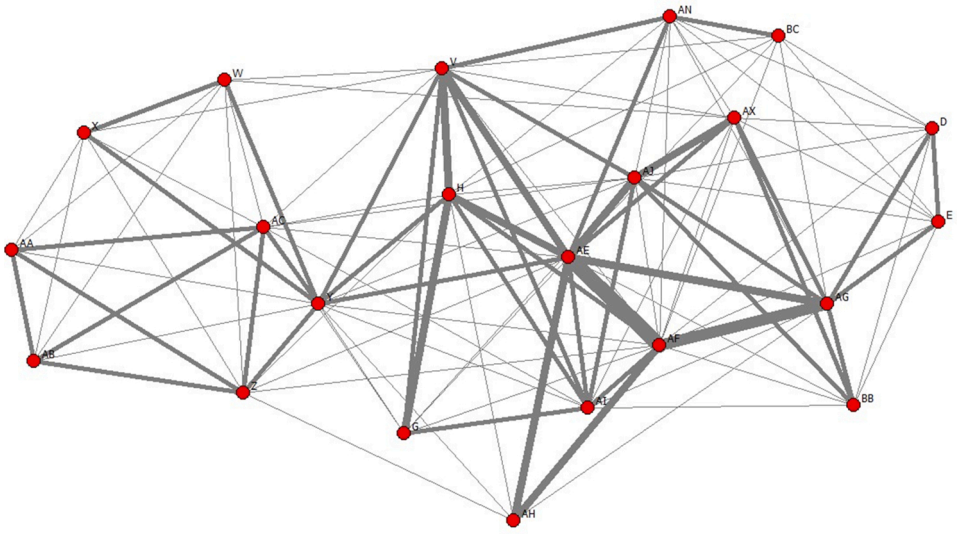

Fig. 3. Teacher Ties Network Clusters Only.

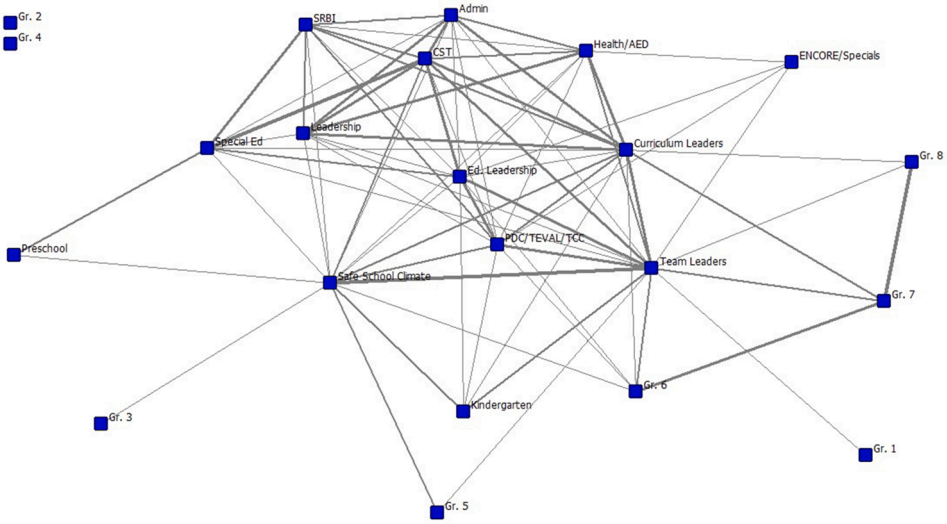

Fig. 4. Team Ties Network.

access to social capital, promote diffusion of innovation, and enhance continuous organizational learning. As Fig. 1 indicates, the ENCORE/Specials and Special Ed teams have the most teacher membership. While this would suggest that these teams' members have greater access to social capital, teacher collaboration, and sharing of ideas and knowledge, the DLT realized that is not the case in this instance. Though these two teams have the most teacher membership, most of the members are not on any other teams, which limits access to social capital and the flow of information. The ENCORE/Special and Special Ed teams appear to be bottlenecks. FC Warren administrators decided to assign those teachers who only belong to the ENCORE/Specials or Special Ed teams to at least one other team so that these teams and team members are better positioned within the network.

School leaders recognized that among their staff, two individuals (nodes AE and AF) are in potentially highly influential positions within the network, i.e. they are members of many teams, eight and seven respectively. However, the teams to which AE and AF belong are clustered (not dispersed) and are predominantly comprised of school administrators, not teachers or other support staff. The Superintendent believes that this structure hampers diffusion and intends to diversify the team memberships of AE and AF so that each individual can access and can be accessed by colleagues from other regions of the school's network.

The issue of limited connectivity to the wider network is particularly salient when considering the Grade 2 and Grade 4 teams, as these teams are isolated from the broader school network. It is necessary for these team members to join additional teams or for faculty from other teams to join these teams so that they have access to the rest of the school network. Additionally, the Grade 1 and 3 teams are only connected to the rest of the network by a single actor who serves as a bridge for the other team members. This means that these teams are not only not connected to one another, but that all the teachers of the earlier grades at the school (i.e., Grades 1 through 4) are largely disconnected from the rest of the schools' teams. Although some teams have a high concentration of team members and some members have membership on multiple teams, overall, this network has very few people who are highly connected (i.e. members of multiple teams) and few teams that have high teacher membership. This could be problematic, as lack of collaboration opportunities between faculty at all levels of the school network constrains the sharing of teaching practices and, moreover, limits the positive influence on student learning and achievement. As a result of examining the sociograms FC Warren administrators decided to create a

new School Instructional Leadership team that would include members from each grade level team and the special education team. The structure of the current FC Warren teacher network impedes teacher collaboration across grade levels, whereas the introduction of the SILT—a new network "actor"—is intended to build a more equitable load among teachers, to reduce components, to promote vertical alignment, and to eliminate bottlenecks and isolates.

While there are limited opportunities for formal collaboration across Grades 1 through 4, there appear to be numerous opportunities for administrators to collaborate, i.e. there are many leadership-based teams, such as the Leadership, Curriculum Leaders, Administration, Team Leaders, and Education Leadership teams. Within these teams, there exists a cluster of individuals who are all on multiple teams together. Given the apparent overlap in purpose and high redundancy in members, the DLT is considering eliminating one or more of them.

In sum, FC Warren school leaders used evaluation findings to make evidence-based decisions about where and how to strengthen network capacity for diffusion of innovation and organizational learning. Their three primary decisions were to: (1) create a School Instructional Leadership Team that will include at least one teacher from every grade level and special education, (2) disband one or more of the existing leadership-oriented teams and, (3) decrease and diversify team membership of two key actors while simultaneously establishing new ties between isolate actors. Additionally, school administrators plan to incorporate the use of SNA into their school improvement plan as a means for monitoring how future programming affects the size, composition, and structure of their school-based social networks over time.

3.2.1. Lessons learned

Social network analysis is a powerful evaluation approach. SNA enables a mathematical and graphic means for determining how relationships between people, organizations, and/or other actors support or constrain individual and organizational outcomes. Evaluation stakeholders in this study found the team and teacher sociograms to be highly illustrative, accessible, and useful. SNA can uncover "hidden" processes that are not well attended to through more traditional social science data collection and analysis methods. Traditional formative and summative evaluation approaches often assess programs and individuals based on astructural characteristics (e.g. number of participants in a program or the gender, race, and/or age of an individual), and do not attend to the affiliations and relationships that directly and indirectly influence individual and organizational performance. Use of SNA for evaluation and program planning may advance our collective understanding of how social networks support (or constrain) an individual's access to the social capital resources they need to feel supported, strengthen their skills, problem-solve, and advance the mission of their organization.

There are factors other than network size, composition, and structure that also affect access to social capital, diffusion of innovation, and organizational learning. In this evaluation, we used SNA to examine a school's formal teaming network. We did not describe or shed light on the important internal team processes and dynamics that are critical to successful teacher collaboration. For example, without facilitation and explicit norms, teacher teams can lapse into peripatetic discussions rather than engaging in problem-solving and disciplined dialogue about instructional practice and student learning (Achinstein, 2002; Venables, 2018a, 2018b). Hence, going forward we encourage school leaders and evaluators to purposefully design and evaluate teaming processes, that is the quality of dialogue, decision-making, and action-taking within a team.

School leaders can have great influence over the size, composition, and structure of intra-organizational social networks. Evaluation, and the use of social network analysis methods in particular, can make it more likely that patterns of communication, diffusion, and collaborative problem-solving happen intentionally and by design, instead of by default.

4. Conclusion

It is recognized that social networks are critical to the attainment of organizational goals and function as one of the most effective ways for professionals to access expertise and support, problem-solve, and innovate. School-based networks are critical to cultivating the work of teaching, learning, and organizational change (Daly, 2010). Increasingly school administrators are seeking to leverage the power of their school's social networks to increase access to social capital, promulgate innovation, and enhance organizational learning. In this study, school leaders used social network analysis findings to advance their District's theory of change. Sociograms were used to envision various networks through which their teachers collaborate, innovate, and problem-solve. Administrators made strategic choices about the existence and membership of teams so as to increase the likelihood that all their teachers could give and receive support through the network. As Bryk, Gomez, and Grunow (2011) contend, "In an arena such as education, where market mechanisms are weak and where hierarchical command and control are not possible, networks provide a plausible alternative for productively organizing the diverse expertise needed to solve complex educational problems" (p. 6). It is our hope that this study may contribute to the growing body of research illuminating the critical role social networks play in the diffusion of innovative of instructional practices and continuous organizational improvement in PK-12 educational settings.

Declaration of Competing Interest

The authors report no declarations of interest.

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