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Chapter 4 Social Network Analysis in K-12 Settings: Review, Implications, and New Directions for Higher Education

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Introduction

Social network theory and analysis have become increasingly relevant as both a framework and set of robust tools for examining social interactions within “people systems.” Its use in educational research has been gaining momentum over the last two decades with much of the work taking place in K-12 settings. Although there have been calls for the use of network analysis in higher education (Kezar, 2014) the work has lagged behind K-12. Therefore, in this chapter, we review and discuss K-12 social network analysis literature to identify implications for its applicability in higher education.

In undertaking the review, we first conducted a comprehensive search of existing literature using terms related to social network theory and analysis. We then narrowed the search to only those that were empirical studies of networks in education settings. We reviewed all relevant publications and then synthesized four major overlapping themes, which arose from that literature and reflect potential implications for higher education as well as high leverage points for network research in future higher education studies. These four themes are: formal and informal networks; quality of ties, nested and multiplex relationships; importance of collaboration; and taking a systems perspective. In this chapter we use the four core themes to organize insights from the K-12 literature as well as implications for future research in higher education. In addition, we highlight some core studies that exemplify the overall theme. Although we review each major section separately for clarity, it should be noted that there is no clear-cut boundary between these areas and in fact there is much overlap and interconnection.

Approach

The idea of social connectedness and social networking gained popularity after entering the public eye with the inception of social networking sites, such as Facebook, which was founded in February 2004. In addition, the number of studies in social networks has grown significantly in multiple fields with advances in technology and computing sciences playing a key role in the increase. Within the last 15 years, the journals “Social Networks” and “Network Science” grew in popularity and influential and popular audience texts on social networks were published (e.g., Christakis and Fowler, 2011). During this same period, network theory research within K-12 settings also grew tremendously (see Figure 1.1). We selected the years 2008-2016 as our review timeframe as the amount of network research in K-12 in that period was significant, including several books on social networks and education that were published during this period.

<FIGURE 1.1 HERE>

Our review includes only peer-reviewed empirical journal articles published between 2008 and 2016 that were conducted in an educational setting focusing on teachers and administrators and took a social network theory perspective or used social network analysis in the collection, analysis, and interpretation of findings. A total of 35 articles met our search criteria. Even though we have not included books in this review, we mentioned them to showcase the growth of the field. The articles were obtained from citations in electronic databases, including ERIC, Web of Science, Educational Research Abstracts, Academic Search Complete, PsycINFO, and Google Scholar. The criteria for selection began with a search command that identified ‘social network analysis in education’ as the key phrase. Subsequent search commands included ‘social network analysis’ as the key phrase, without the addition of ‘education’ and ‘social network theory in education’.

A list with all the printed titles and abstracts was compiled and reviewed to identify all studies that employed any form of social network analysis in education. A total of 265 studies were initially included in the list. However, a closer review of the studies enabled us to remove 123 studies that were not peer-reviewed, not relevant to education, not actually social network analysis, or were not strictly empirical (i.e. collection and analysis of primary data). We then further reduced the sample of work to that only related to K-12 settings. Our final sample contained 35 peer reviewed journal articles. This list (see Appendix A) only included empirical studies where social network analysis occupied a significant part, usually as a method of data collection and analysis or a theoretical framework or indeed a combination of these. In addition to understanding our inclusion criteria, it is worthwhile to note what we excluded for the purposes of this review. There were a number of papers on social media, health, business, and some in higher education that were not included for the review.

We carefully reviewed all papers, created a database and recorded details about design, sample, theory, analytic techniques, and main findings. We then analyzed the database using thematic analysis (Boyatzis, 1998) and arrived at four major cross cutting themes. We privileged the most common cross cutting themes with an eye toward what may also be of use in a higher education setting. The four themes are: formal and informal networks; quality of ties, nested and multiplex relationships; importance of collaboration; and taking a systems perspective. In the following pages of the chapter we unpack each of the main themes and provide a few sample pieces that illustrate the theme.

Formal and informal networks

It was clear from our review that a core element in the K-12 social network literature was the importance of both informal and formal systems. A formal network is one that is codified and is generally explicit relying on titles, roles, and clearly identified positions. A formal network in a

school involves those with an official title and the set interactions that may follow. For example, in a formal network the “instructional coach” who holds the title would be the one that provides the coaching role in a school. An informal network among actors is not imposed or predefined and sets of interactions can move beyond formal roles. An informal network allows its members to move in any direction, move outside of traditional authority roles, and is more socially structured. For example, the most influential person in a school network may not be the principal but could be any other actor within the network regardless of title. Social network analysis allows researchers to examine both formal and informal aspects of school systems, especially with regards to the importance of informal structures in facilitating or impeding leadership, instructional change, and school improvement. For example, a leader may be formally well-positioned in a school system but informally remain weakly socially connected to others in the system, which may have a negative impact on leadership and wider school change. It has increasingly been argued that the informal social linkages on which reform is layered may support or constrain the depth of a change effort (Daly, Moolenaar, Bolivar, & Burke, 2010). Our review identified several studies that have examined formal and informal networks in K-12 (Daly, Finnigan, Jordan, Moolenaar, & Che, 2014; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Penuel et al., 2010; Penuel, Riel, Krause, & Frank, 2009; Spillane, & Kim, 2012).

A central theoretical concept that grounds much of social network theory and analysis research in K-12 is that of social capital. In identifying factors that may account for the development of social capital, two studies explored social tie formation in schools by focusing on advice and information providing and receiving (Spillane, Kim, & Frank, 2012; Spillane, Hopkins, & Sweet, 2015). In doing so, they examined the role of both formal organizational structure and of the individual characteristics of school staff in shaping advice and information providing and receiving about instruction. Data were collected from 30 elementary schools in a mid-sized urban U.S. school district. The findings of these studies suggest that while the individual characteristics of race and gender are significantly associated with the formation of a tie, aspects of the formal school organization, such as grade-level assignment, having a formally designated leadership position, and teaching a single grade, are also significant and have larger estimated effects than individual characteristics. The authors argue that social ties among actors in schools are a necessary condition for social capital because in the absence of such ties, individuals do not have access to social resources (Spillane, Kim, & Frank, 2012; Spillane, Hopkins, & Sweet, 2015).

An in-depth study by Penuel et al. (2010) examined the alignment of the informal and formal organizational supports for reform for improving teaching in two elementary schools in California. The authors argued that when the formal organization of a school and patterns of informal interaction are aligned, faculty and leaders in a school are better able to coordinate instructional change. By fitting multilevel social selection models (SSMs¹) to longitudinal social network data collected from surveys, the authors estimated the relative influence of formal and informal processes on patterns of advice giving in each school (Penuel, et al., 2010). Their social network data analysis showed distinct patterns in each school that helped explain why one school had been successful in developing a shared vision for instructional change whereas the other school had not been successful. A main take away message of this is that the better internal

¹ Social selection models (SSMs) incorporate nodal attributes as explanatory covariates for modeling network ties.

alignment of the formal and informal networks in the system the easier it is to develop shared vision and move the system toward change as everyone has access and knowledge about the same set of resources. This study's findings suggest the potential of social network analysis in exploring how analyzing informal social interactions can help explain why some reforms take hold in schools and others do not. This indicates that the better aligned formal and informal networks, the more successful the change effort.

Examining individual level impacts, Penuel et al. (2009), drawing on the same sample, investigated the role of formal and informal teacher interactions in helping teachers enact changes to instruction associated with ambitious school reforms. The authors concluded that analyzing the internal informal structure of the school community was necessary to help account for the distribution of access to resources and expertise in the two schools. Moreover, they presented evidence to show that the distribution of valued resources and expertise through the "informal" channels was related to the level of change observed in each school (Penuel, et al., 2009). At the district level, Daly et al. (2014) published a study that explored the interactions of 256 district leaders as brokers in the use of data as research evidence for district and school improvement. A misalignment between formal (theory of action in the district) and informal systems (the way in which the change strategy played out) was found. The authors argue that while the overall macro system (conceptualized as the overall change intentions of the district) exerted significant pressure on improvement, the micro-level interactions between and among actors did not necessarily reflect those macro emphases. Hence, the micro-level social interactions within informal systems may catalyze improvement efforts that go outside of the formal structures.

Spillane and Kim (2012) examined how designated formal school leaders are positioned in their school's instructional networks by analyzing data from all 30 elementary schools in one mid-sized urban school district. In particular, they explored relations between an aspect of formal organizational structure and the relational informal structure by looking into the positioning of formal leaders in their school's instructional advice and information networks for mathematics and language arts. Their analysis suggests that formal leaders, especially part-time leaders as opposed to full-time, played prominent roles in these networks and were central in brokering relations among staff in the mathematics and language arts networks. Spillane and Kim (2012) also concluded that formal school leaders' positioning in the advice and information networks is positively associated with their school's alignment with external government standards and their school's normative structure. Normative structure could be conceptualized here as the way in which folks relate—what is expected in terms of how individuals interact across the institution. In further illustrating the idea of formal and informal networks, Frank et al. (2011) investigated how knowledge flows into schools for the implementation of technological innovations. The study included 470 teachers in 13 elementary schools across one Midwestern state. The authors concluded that the more teachers at the lowest initial levels (those who have implemented the innovation at very reduced levels) of implementing an innovation are exposed to formal professional development focused on student learning, the more they increase their level of implementation; the more teachers at an intermediate initial level of implementation have opportunities to experiment and explore, the more they sustain their level of implementation; and the more teachers at a high initial level of implementation access the knowledge of others

(informal system), the more they increase their level of implementation. Overall, teachers found it difficult to sustain high levels of implementation in the absence of interaction with colleagues (Frank, et al., 2011). This study indicates that the interrelationships between formal and informal structures may be crucial for increasing the success of implementing technological innovations within elementary school settings.

Taken together, this set of work indicates the interacting and sometimes conflicting roles of formal and informal networks. Often the space between what is put forward in the formal structures does not result in alignment to the actual work of the actors within a system. Understanding those patterns and where there is a disconnect between formal and informal offers a high leverage point to examine change strategy (see Chapter 2, this volume). Future work in higher education may benefit from the examination of the alignment between formal and informal networks as work in K-12 would suggest these systems often look quite different. Given these findings, studies in higher education should not restrict themselves to only examining actors in formal roles, but rather extend samples out to include many more actors who may occupy informal leadership or relationship positions that have influence on change (see Chapter 2, this volume). In addition, this work suggests an opportunity to examine how formal programs in their conception and articulation actually align with the informal execution of plans. Literature outside the field of social networks suggests the important role of sensemaking when it comes to implementing programs. A more detailed discussion on sensemaking is offered in chapter 5. Sensemaking (i.e., meaning making) happens both within individuals as well as between them in an active social system, which means the meaning making that takes place could well be happening outside formal systems. Using social networks to explore the implementation of programs or formal change strategies within higher education departments may be useful.

Quality of ties, nested, and multiplex relationships

Social network analysis is concerned with the pattern of social ties that exists between actors in a social network. Social network studies in education, as in other fields, primarily focus on how the constellation of relationships in networks may facilitate and constrain the flow of relational resources, such as attitudes and knowledge, as well as providing insight into how individuals gain access to, are influenced by, and leverage these resources (Daly, 2012). The quality of those nested and multiplex relational ties (see Chapter 3, this volume) is of paramount importance in creating and maintaining an organic and safe space for change to occur. This suggests the importance of moving analysis from a focus on only the individual to examining the complex ecosystem of relationships that surround actors. Beyond just the set of ties that surround an actor, those ties may also be imbued with different levels of trust, which is an important aspect of tie quality along with reciprocity, and closeness as other elements. The idea of interdependency is also central to social network theory and analysis and is often referred to as “social embeddedness” (Daly, *ibid*), which, in a general network sense, refers to the nested and multiplex nature of relations in a social structure.

Work in K-12 highlights the importance of the quality of the relations between actors and the importance of network structures such as mutual or reciprocated ties (chapter 3). The quality of

ties can be deepened based on positive experiences from prior social interactions and may foster trust by reducing uncertainty about the engagement and involvement of the other party. This predictability of relations gained through reciprocal interactions both decreases the vulnerability between individuals as well as potentially increases the depth of exchange due to a willingness to engage in risk taking, meaning taking an action that goes outside the typical repertoire of activity for an individual (Daly, & Finnigan, 2012). In support of this claim, research suggests that individuals tend to seek reciprocal as opposed to asymmetric relations, as those ties provide mutual benefit to the relationship in effect creating a reinforcing effect (Daly, & Finnigan, 2010). Reciprocated relations are therefore important in providing opportunities to build and deepen the norms of trust necessary for the exchange of reform related resources and are related to the quality of ties between individuals.

Reciprocity and trust are also implicated in research related to communities of practice (Lave & Wenger, 1991). Reciprocated relations provide opportunities for individuals to interact and learn together and have been suggested to be important in educational systems oriented toward learning (Honig, 2008). These trusting and reciprocal relations can provide the opportunity to modify and deepen patterns of interaction as well as develop increased repertoires of behaviors, which may be thought of as a process of learning necessary for improving practice (Lave & Wenger, 1991). On balance this literature suggests that actors who perceive trusting relations with one another may also have reciprocated relations and as such, levels of reciprocity have been shown to be related to high quality ties imbued with trust (Daly, & Finnigan, 2012).

High trust reciprocal exchanges have been shown to be associated with the movement of complex information as well as providing for a safe psychological space for exchanges to occur (Daly, 2010). As such, it is important to attend to both the nested aspects of relationships as well as the quality of the exchanges between actors within that space. Several studies have explored these interdependent aspects of relationships, particularly those infused with trust and reciprocal exchanges (Daly, 2009; Daly, Moolenaar, Liou, Tuytens, & Del Fresno, 2015; Maele, & Houtte, 2009; 2011; 2012). For example, Maele and Houtte (2011) investigated how structural, compositional, and cultural characteristics of the teacher workplace affect an individual teacher's trust in colleagues by exploring whether a homogeneous staff culture facilitates trust among teachers. Their sample included 2,104 teachers across a representative sample of 84 secondary schools in Flanders, Belgium. The findings revealed that collegial trust is fostered when teachers agree on expectations of learning potential for students in school, whereas the presence of a less homogeneous learning oriented culture explains the lower levels of collegial trust in socioeconomically disadvantaged schools. The authors argue that school leaders should focus on developing similar and positive conceptions among their teachers about expectations in order to build social capital within the teaching staff to benefit student learning.

Maele and Houtte (2009) also explored the extent to which teachers from a same school share a level of trust by drawing on the same sample. To examine the existence of faculty trust, 29 scale items were used. Trust is defined as a collective feature of teachers instructing at the same school. This study reported that trust exists within Flemish secondary schools and organizational value culture, size, and group composition are associated with faculty trust in students, parents, colleagues, and the principal. The authors concluded that programs should be adopted to enhance teacher trust and that leaders should be aware of organizational characteristics affecting trust in

schools (Maele, & Houtte, 2009).

In a companion piece, Maele and Houtte (2012), drawing on the same sample, examined the relationship between trust and the teachers' job satisfaction. The findings revealed positive associations between teacher trust in students, parents, colleagues, and the principal and teachers' satisfaction with their jobs, highlighting the social dimension of teaching. The study suggests improving the quality of teachers' social relationships in the workplace should enhance their job satisfaction. Daly's (2009) study on the potential of leadership and trust has also indicated that the presence of trust and leadership approaches that are participative and inclusive predicted lower levels of threat-rigid response by teachers and administrators in program improvement schools. The threat rigidity thesis offers that as systems are under perceived threat they narrow their range of responses, limit communication, and make reactive decisions. This threat rigidity study utilized instruments to measure threat-rigidity, trust, and leadership. Teachers and site administrators were surveyed and participated in focus groups and interviews respectively in four districts to test the hypothesis that the multifaceted construct of trust and leadership has a predictive relationship with threat-rigid response. Based on the study's findings, Daly (2009) highlighted the expanding role of trust as a resource for schools and districts that are negotiating accountability demands. Daly led another study on the importance of collaboration among district-office and school leaders by exploring negative relationships between educational leaders (Daly, et al., 2015). Survey data were collected from 78 educational leaders on perceptions of culture and negative relationships. Social-network analysis was employed to examine the likelihood of leaders forming negative relationships. Their findings indicate that those that more often identified others with whom they had a negative tie tended to be district-office leaders, who often reported higher efficacy and perceived less trust, whereas those who were often identified as individuals with whom many had a negative relation were more likely to perceive more trust and have been employed in the district longer.

Price (2015), making the point with a different set of actors, studied the social interactions between principals and teachers, particularly looking at how these interactions may impact teachers' perceptions of their students' engagement with school. In doing so, Price (*ibid*) empirically tested the theoretical proposition that principals influence students through their teachers in the US charter school environment. She analyzed the pooled network and survey data collected in 15 Indianapolis charter schools, with findings indicating a relationship between principal-teacher interactions and teacher perceptions of student engagement. The author argued that moving beyond principals' personality dispositions in management and turning to the high quality social relationships that they form with teachers adds to the understanding of how a principal's leadership affects student learning. Therefore, the quality of ties between the two ultimately influences student achievement in an indirect manner. Price (2015) concluded with implications on practice by highlighting that the relationships principals build with teachers are implicated on the beliefs of trust and support among teachers in a school and have a ripple effect on teachers' perceptions of student engagement.

Much of the work in K-12 suggests that there are multiple types of relationships between individuals (Daly, 2010). Multiplexity refers to the embeddedness of more than one type of network relations between actors (Scott, 2011). A tie between two actors is considered as multiplex when their connection is defined by more than one network relationship. For instance,

if A has a friendship with B, works for B, and also seeks advice from B, the relational tie between A and B is thus multiplex (friendship *and* work-related professional ties). Sociologists assume that people tend to possess more than one relation that is activated under certain contexts and those relationships can be considered of higher quality (Daly, 2012). This concept is particularly important in organizational network studies as individuals can leverage their capital resources to achieve purposive goals through engaging in interpersonal communications and collaborative work with their colleagues (Liou & Daly, 2016). Since multiplexity provides additional complexity in interpreting the quality of ties between individuals, it is often used as a measure of tie strength in social network studies (Hanneman, & Riddle, 2005). Actors that are tied by more relations share a stronger tie than those tied by fewer relations (Hanneman, & Riddle, 2005). Such strong ties facilitate the flow of tacit, complex, and timely information exchanged between actors (Daly, & Finnigan, 2010).

The studies above have presented evidence suggesting that not only is the presence of relationships important for allowing change to occur, but also the quality of those social ties is equally important in creating a safe space for educators to mutually and rigorously examine practice (Daly, 2012). This in turn has many implications and potentially can provide various opportunities for higher education research and practice. For example, social network studies in higher education should consider attending to the quality of ties as well as the quantity of ties. A recent study by Mamas (2017) found a dynamic interrelationship between friendship relational ties and group work learning in undergraduate students, which is related to the role of instruction in higher education. Research on students' networks as sources of academic, social and emotional support should be high on the agenda of transforming higher education teaching and learning. This becomes even more timely with the epidemic of stress and increasing mental health issues that students must cope with, alongside their studies. Maintaining a safe environment imbued with trust may be key for enhancing students' well-being and sense of belonging. The line of work around the quality of ties indicates that the act of teaching and learning in higher education is far more than a technical exercise and requires greater attention to the socio-emotional aspects of the instructional endeavor. Moreover, the quality of relations between and among academics as they go about their scholarship may well be influenced by the quality of ties they have with one another.

As we noted above, in systems we can be just a colleague or a friend or an advisor or any number of other types of relationships. Each of these types of ties are important in and of themselves. However, as is often the case we have multiple relationships with a single individual—we can be work colleagues *and* friends. When relationships are “multiplex” or span more than one type of relationship, these ties have the potential to be even stronger as the quality of those ties is deepened. Individuals that turn to work colleagues who are also friends are likely to receive advice at a deeper level given the high quality nature of the relationship. When change is considered within higher education, this effort may be inhibited or enhanced due to the nested and multiplex nature of relationships across an institution. Consider how much of higher education is based on “peer review.” How might multiple relationships influence the peer review processes? Can reviews be completely unbiased when those under review are friends with reviewers, or can reviews be unbiased when individuals have violated some norm against another? The idea that individuals are embedded in a wider system of relations that vary in their

quality and composition may offer rich leverage points for work in higher education.

Importance of collaboration

Many studies within K-12 social network research have focused on the importance of educators' collaboration and development of overall learning communities. It has been argued that teachers' social networks can play an important role in teacher learning and organizational change. Traditionally, teaching has been perceived as an individual endeavor whereas, more recently, teachers' training and professional development has increasingly centered on collaboration, mentoring, and professional community building and the positive outcomes associated with such structures (Baker-Doyle, 2015). Therefore, this section reviews studies on how social network structures underlying collaboration may be related to schools' capacity to change (e.g. Coburn, & Russell, 2008; Farley-Ripple, & Buttram, 2015; Moolenaar, Slegers, & Daly, 2012; Penuel, Sun, Frank, & Gallagher, 2012; Sun, Penuel, Frank, Gallagher, & Youngs, 2013). The balance of work in this area indicates that densely connected networks of strong ties supports collaboration and depth of change efforts. This general finding suggests that examining the extent to which communities of practice and learning are present in higher education may be associated with outcomes of importance.

The importance of collaboration in promoting diffusion of instructional expertise among teachers through high-quality professional development has been found to be associated with providing more help to colleagues on instructional matters (Sun, et al., 2013). The authors drew on longitudinal and sociometric data from a study of writing professional development in 39 schools. Collegial interactions were shown to generate both direct and collateral impacts on those with whom colleagues were socially tied thus emphasizing the role of professional communities in supporting instructional improvement. Drawing on the same longitudinal study, Penuel et al. (2012) investigated how collegial interactions can augment the mechanism of teachers' learning from professional development. Their analysis included social network data and self-reports of writing instructional practices from teachers in 20 different schools, as part of the National Writing Project's partnership activities. The results indicated that both organized professional development and interactions with colleagues who gained instructional expertise from participating in prior professional development were associated with the extent to which teachers changed their writing processes instruction. In conclusion, the authors argue for the potential for using data on teachers' social networks to explore indirect effects of professional development (Penuel, et al., 2012).

An interrelated aspect of teacher collaboration concerns the use of data in building schools' capacity to improve teaching and learning. In one such study, Farley-Ripple and Buttram (2015) explored the development of data use capacity in an elementary school through a social network approach. According to the authors, the use of data to improve teaching and learning have grown exponentially. Their findings revealed that data use networks (the set of interactions around how individuals use data for instruction) are influenced by the larger professional structure of the school and may be productive in developing shared practices. The authors concluded that advice networks specifically related to data use may be effective in establishing shared practices within the school community. Daly's (2012) work provides a comprehensive overview of data use and

social networks in educational improvement.

In a large-scale study conducted in 53 elementary schools in the Netherlands, Moolenaar, Slegers, and Daly (2012) have found that well-connected teacher networks are associated with strong teacher collective efficacy (the overall sense that a group of teachers perceives being efficacious), which in turn supports student achievement. The authors argued that collective efficacy is a powerful concept for both leadership and the successful implementation of reform. Drawing on the same schools, the dimensionality of seven types of social interaction in schools was assessed using social network data of 775 educators (Moolenaar, Slegers, Karsten, & Daly, 2012). The findings suggest small to moderate similarity between the seven forms of social interaction. The authors argue that collaborative initiatives among educators are important and that the social networks that underlie these collaborative initiatives are shaped by the type of social interaction among educators, and as such may be specifically targeted to optimally facilitate organizational goals, underscoring the role of multiplex relationships.

Another large-scale study in the Netherlands, undertaken in 51 elementary schools, included 702 teachers and 51 principals. This study investigated the relationship between transformational leadership, social network position and schools' innovative climate (Moolenaar, Daly, & Slegers, 2010). Using social network analysis, the findings indicated that transformational leadership and principals' social network position were positively associated with the schools' innovative climate. Additionally, the more principals sought professional and personal advice and the more closely connected they were to their teachers, the more willing teachers were to invest in change and the innovation. In a similar study and drawing on 708 teachers across 46 Dutch elementary schools, Moolenaar and Slegers (2014) found that principals who occupy a central position in their school's advice network are also more likely to occupy a central position in their district's collaborative leadership network. Moreover, transformational leadership was found to affect the extent to which principals are central in both networks (Moolenaar, & Slegers, 2014).

Additional work has examined the relationship between organizational factors, teachers' professional development and occupational expertise through a survey of 152 secondary school teachers (Evers, Heijden, Kreijns, & Gerrichhauzen, 2011). Participation in social networks was found to have a positive influence on the development of occupational expertise and the availability of organizational facilities appeared to contribute positively to the amount of teachers' professional development. According to the authors, managers and leaders in schools should not only be investing in traditional formal training activities, but also providing opportunities and creating the conditions for participation in social networks as it contributes toward enhancing occupational expertise. In a similar vein, Baker-Doyle and Yoon (2011) investigated informal advice networks of a community of teachers in an in-service professional development program aiming to study the social networks developed by the teachers as well as to examine whether these networks maximized teachers' access to practitioner-based social capital. The practitioner-based social capital has been defined as the knowledge and resources for teaching practice that are accessible through a social network (Baker-Doyle, & Yoon, 2011). The authors were interested in the tacit and explicit knowledge to teach STEM effectively. The findings indicated that teachers did not naturally build advice networks that would cultivate the highest levels of practitioner-based social capital and highlighted the possibilities arising from

social network research on teachers' learning communities in understanding the dynamics of teacher networks. Baker-Doyle (2012) also carried out a mixed-methods study on first-year urban teachers' social support networks by collecting and analyzing social network data on the support networks of 24 first-year teachers. Findings of the analysis identified two important networks of support for the new teachers, including intentional professional networks and diverse professional allies. According to the author, these findings have important implications for the ways in which administrators, policy makers, teacher-educators, and teachers can conceptualize and nurture teacher support networks and the interactions and relationships that influence teacher professional support (Baker-Doyle, 2012).

At a school district level, Stein and Coburn (2008) explored the usefulness of communities of practice theory for understanding how districts can create organizational environments that foster teachers' opportunities to learn the new ideas and practices required to carry out ambitious reforms. They drew on data from a longitudinal study in four schools across two urban districts in the US. Primarily, the district reform effort in one district led to significant opportunities for teacher learning and alignment with reform goals while efforts in the other district coordinated action but failed to generate meaningful opportunities for teacher learning (Stein, & Coburn, 2008). In another similar study drawing on Mathematics reform in four elementary schools, Coburn, Mata and Choi (2013) studied the embeddedness of teachers' social networks, as it can play a key role in teacher learning and organizational change. Their findings indicate that teachers' social networks are embedded in and affected by their policy context, as school-level policy can influence the tie formation process by creating new structures for regular and sustained interaction. This study has also provided insights into the role of policy in providing the resources that can be accessed via social networks. Furthermore, Coburn and Russell (2008) explored how district policies influence teachers' social networks in eight elementary schools in two districts involved in the scale-up of mathematics curriculum by drawing theoretically on social capital theory and methodologically on qualitative social network analysis. Their study highlighted that policy affects whom teachers seek out for discussion of mathematics instruction and that school leaders mediate district policy, thereby influencing these patterns of interaction.

In two case studies within the Finnish special education context, the social networks of special educators were examined. First, a special educator's social embeddedness and activity in his workplace community and external professional network has been explored (Tuomainen, Palonen, & Hakkarainen, 2010). The results of this study showed that the special educator utilized a special education related multi-professional network and had very significant roles both as a knowledge source and collaborator. Second, Tuomainen, Palonen and Hakkarainen (2012) assessed the networking roles and practices of special educators by employing a social network analysis multiple case study framework, that included three special educators in a Finnish part-time special education context. Their results revealed that special educators remained at the periphery of the informal teacher communities whereas their networking practices involved activating various outside professional relationships that provided expert resources needed in their profession. Both studies concluded that special educators may be characterized as network experts, who appear to work at boundary zones between school communities and the outside world.

A number of studies focus on systemic and sustainable instructional reform in the context of

collaboration (Coburn, Russell, Kaufman, & Stein, 2012; Daly, Moolenaar, Bolivar, & Burke, 2010). For example, Daly, et al. (2010) studied teachers' social networks and how teachers' social relationships may support or constrain systemic reform efforts. A mixed-methods exploratory case design was implemented in five schools within one under-performing school district undergoing a system-wide reform. Results from this study revealed significant variance within and between schools in terms of reform-related social networks whereas these networks were found to be significantly related to the uptake, depth, and spread of the change. Moreover, densely connected grade levels were also associated with more interactions focused on teaching and learning and an increased sense of grade level efficacy (Daly, et al., 2010). The authors concluded that attending to relational linkages is key, as social networks were found to significantly facilitate or constrain reform efforts. Similarly, Coburn et al. (2012) investigated the relationship between teachers' social networks and sustainability by qualitative social network analysis and qualitative comparative analysis as part of a longitudinal study of the scale-up of mathematics reform. Teachers' social networks in the first 2 years of the initiative influenced their ability to sustain reform-related instructional approaches after supports for reform were withdrawn. Additionally, social networks with combinations of strong ties, interactions focused on the specific problems of practice, and high expertise enabled teachers to adjust instruction to new conditions while maintaining the core pedagogical approach (Coburn, et al., 2012).

The results from studies reported in this theme on collaboration have the potential to help transform the space of higher education. Traditionally, academics tend to work in silos with limited interaction with colleagues and the wider field of practice. Following the example of K-12, collaboration may be key for enhancing faculty development around teaching and learning as well as bridging the gap between higher education research and practice. Understanding the social infrastructure of a department would be the first step towards creating the conditions for collaboration to grow. Studies in K-12 have shown that there is a relationship between departmental social structure and outcomes, particularly in teacher learning and organizational change. Those findings tend to be consistent across the studies reported in this section and may provide various opportunities for higher education research and organizational change. More recently, interdisciplinary work is gaining ground within the field of higher education.

Some early work in faculty development by Waes et al. (2016) indicates that professional community between and among new faculty members supports improvements in instructional capacities. Much of higher education is set up on a competition frame with individuals being incentivized for sole action (Kezar, 2014). Moving beyond this silo mentality to support collaboration reflects a rich area for both study and action. Social network analysis and theory offer ample opportunities for examining interactions within departments as well as interdisciplinary teams and as a way to examine both supports and constraints for action. As shown in K-12 studies, social relationships among educators are vital for organizational improvement and social network research provides the set of tools that enable for the invisible social structure to become visible. Attending to these more nuanced aspects of reform as well as the more formal organizational structures provides a more holistic and organic framework for reform to succeed.

Taking a systems perspective

Improving low-performing K-12 schools and wider school districts has been at the heart of educational research for a long time, but with limited success. The literature has recently begun to include more about a ‘systems perspective’, by exploring linkages between different levels of the system (Daly & Finnigan, 2016). This section discusses implications arising from social network studies that have examined change from a systems perspective that embraces the complexity and nuance that is inherent when examining interconnected parts of a system. The implication for network studies in higher education is to not just examine singular programs or departments, but to conceptualize and investigate change that happens in the spaces between different levels and aspects of higher education (e.g. between departments or between departments and the rest of campus). Studies at the systems level can be well examined using a network perspective.

Recognizing that improving education is complex work with limited success at scale, has led scholars to shift attention to the broader *system* in which schools reside and to exploring linkages between central offices and sites in engendering change (e.g., Hubbard, Mehan & Stein, 2006; Marsh, 2002). In addition, a host of non-system actors or intermediaries play roles in the spread of knowledge, information, and other resources throughout a school system (Penuel, Korbak, Sussex, Frank, & Belman, 2007). The growing body of network research highlights the importance of focusing on the larger system and various connection points, rather than school-by-school change. This prompts us to borrow a term from Smylie, Wenzel, and Fendt (2003), who argue that it is time to “...*think systemically* about schools and their development and see educational organizations in terms of their interdependent parts” (p. 155).

As an example, Finnigan and Daly (2012) conducted an examination of whether schools under sanction for underperformance exhibit the necessary processes, relationships, and social climates that support organizational learning and improvement. In doing so, they also investigated the degree to which length of time under sanction affects these processes, relationships, and social climates of schools as well as the extent to which the relationships and climate of the larger district facilitate or hinder improvement in schools under sanction. A case study design was employed with the cases being three secondary schools across one school district. A survey was administered to 138 teachers and administrators within the schools and to 108 participants from the district’s leadership team. In addition, 30 interviews were conducted with school staff. Finnigan and Daly (ibid) found that sparse ties within these under sanction schools, which indicated limited connectedness of staff, particularly in comparison with those schools that were not under sanction. They also found school climates that did not support collaboration around change efforts that were necessary to bring about organizational learning and improvement. In sum, negative social climate and weak underlying relationships between district leaders inhibited the flow of ideas and practices district-wide, especially to these low-performing schools (Finnigan, & Daly, 2012).

In a similar set of studies by the same authors, (Daly, & Finnigan, 2010; 2011), the importance of school district offices in supporting reform was examined, emphasizing the socially constructed nature of organizational reform efforts. In particular, they explored the underlying reform-related social networks of central office and site leaders, as they may provide insight into

how relational structures support or constrain efforts at reform. Implementing a longitudinal case study, they drew upon social network analysis and interviews to examine the reform-related knowledge, advice, and innovation network structures in a district facing sanction for underperformance and engaging a districtwide reform. The findings indicated that over time, the networks increased the number of superficial interactions, and more frequent exchanges remained unchanged, thus resulting in a centralized network structure. Furthermore, reform-related networks tended toward closed, reciprocated relations that primarily occurred within specific work locales (district or site) and the knowledge network became more centralized and internally focused over time, with district office leaders playing a central role and site leaders residing on the periphery (Daly, & Finnigan, 2010; 2011). This centralized and internally focused structure inhibited the infusion of ideas, knowledge and practices across the system and constrained the diversity of perspectives.

Daly, Liou, Tran, Cornelissen, and Park (2013) highlight the role of the district from a systems perspective. Using advice social network data from 72 district and 76 site leaders, they found that leaders with more incoming advice relationships from other leaders were associated with more years of experience in the district, being self-identified as ‘neurotic’, reporting higher efficacy in leading reform, and less efficacy in management. Overall, their results denote the importance of considering both personality traits as well as perceptions of efficacy in terms of understanding how leaders come to occupy influential social position in an advice network related to reform (Daly, et al., 2013). The bulk of this work suggests that organizations as systems are complex and it is vital to remember the combination of all of the “parts” of a system are important and better understanding how they interact will be necessary in moving work forward. Networks and systems help to directly influence and empower those who are a part of them through transferring knowledge, creating trust, and opening doors of opportunity as well as keep individuals who are not a part of the system on the outside.

Taking a systemic perspective in higher education can be both valuable and transformative in various ways (see Chapter 5, this volume). K-12 research has many lessons to offer in terms of conducting research at different levels of the system. Improving a big organization, such as a higher education institution, can be a huge challenge. Despite the relative autonomy of universities, they reside in wider systems and communities by which they are both influenced by and influence. For example, federal and state policy levels may enhance or inhibit the ability of a university to accomplish its mission. Especially when it comes to streams of research funding, decisions at those levels of the system may have a profound effect on universities. Conceptualizing the educational pipeline as a system from pre-school to higher education is well situated to examination from a network perspective given the ties between elements of the system.

In addition, in higher education there are not only ties within universities or departments, but as scholarly efforts become more interdisciplinary examining the ties across various units may provide insights into connection points and opportunities to engage in innovative work. Moreover, as the work of scholars is often distributed over individuals and institutions, better understanding the larger network of connections may also reveal high leverage points to advance work further or even help to explain gap areas in progress. As universities become more decentralized, systems’ potential impactful work at the network level of a university would be of

great interest.

Another ubiquitous pattern we see in higher education is the increasing role of social media and online courses. These new configurations in the higher education space also lend themselves well to conceptualizing and being thought of as part of the system. Given that students are a critical part of higher education system and increasing numbers of students in higher education are forming communities that are outside the face to face instructional structure and to date we have limited knowledge about how this virtual system may or may not impact instructional progress and the supportive and constraining conditions around these virtual systems. We have some tantalizing evidence about the role of social media in policy (Supovitz, Daly, del Fresno, & Kolouch, 2017), but to date we have limited study or evidence from the virtual system surrounding contemporary higher education settings.

Conclusion

In this chapter we reviewed 35 studies involving social network analysis in K-12 educational settings. In so doing, we highlighted the implications and opportunities for higher education. Four key themes were identified that translate into four main lessons. First, the distinction between formal and informal networks was found to be important when conducting social network studies.

- Lesson 1: Higher education institutions, departments, instructors and so forth should be paying attention to their informal social structure alongside the formal structure as this provides a better understanding of the organization necessary to catalyze change and reform.

Second, the quality of nested and multiplex relational ties has been discussed, as relational resources, including knowledge and attitudes, flow through those ties.

- Lesson 2: The quality of nested and multiplex relational ties can be of paramount importance in creating and maintaining an organic and safe space for change to occur in higher education.

Trust is a vital ingredient for relationships to flourish. As the literature in this chapter suggests, we have become better in assessing levels of trust within systems and more work needs to be done in terms of how to nurture trust within a system. Third, the importance of collaboration has been highlighted within the reviewed studies. Research in K-12 has shown that when educators and other stakeholders have more cohesive, collaborative learning communities then reform initiatives are more likely to be successful.

- Lesson 3: Higher education institutions can benefit from social network research focusing on collaborative work.

Fourth, a number of studies reviewed showed the significant impact that systemic thinking and action can have on improving K-12 education.

- Lesson 4: A systemic perspective can be used in higher education reform efforts by employing social network analysis research and theory to examine different layers of a system, including individual students, groups of students, departments, whole

universities, as well as outside influences.

Looking at a system from different perspectives may provide a lot of opportunities for advancing the higher education research agenda.

In sum, in this chapter we have put forth a networked approach for thinking about change and improvement that takes a systems perspective, which has at its core the quantity and quality of relationships between individuals. The work is about considering and better understanding what moves a community of learners to become a community that learns. To that end in this chapter we view the educational world through the lens of relationships, connectedness, and interdependence. If we embrace a systems perspective in the end, it is less about K-12 *or* higher education, but rather the two segments being part of a larger system that to date has not done a thoughtful job of learning from the other—this chapter and the work that is contained in this book is one small step toward that longer journey.

References

Baker-Doyle, K. J. (2012). First-Year Teachers' Support Networks: Intentional Professional Networks and Diverse Professional Allies. *The New Educator*, 8(1), 65-85. doi:10.1080/1547688x.2012.641870.

Baker-Doyle, K. J. (2015). Stories in networks and networks in stories: a tri-modal model for mixed-methods social network research on teachers. *International Journal of Research & Method in Education*, 38(1), 72-82. doi:10.1080/1743727x.2014.911838.

Baker-Doyle, K. J., & Yoon, S. A. (2011). In search of practitioner-based social capital: a social network analysis tool for understanding and facilitating teacher collaboration in a US-based STEM professional development program. *Professional Development in Education*, 37(1), 75-93. doi:10.1080/19415257.2010.494450.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. sage.

Coburn, C. E., Mata, W. S., & Choi, L. (2013). The Embeddedness of Teachers' Social Networks. *Sociology of Education*, 86(4), 311-342. doi:10.1177/0038040713501147.

Coburn, C. E., & Russell, J. L. (2008). District Policy and Teachers' Social Networks. *Educational Evaluation and Policy Analysis*, 30(3), 203-235. doi:10.3102/0162373708321829.

Coburn, C. E., Russell, J. L., Kaufman, J. H., & Stein, M. K. (2012). Supporting Sustainability: Teachers' Advice Networks and Ambitious Instructional Reform. *American Journal of Education*, 119(1), 137-182. doi:10.1086/667699.

Daly, A. J. (2009). Rigid Response in an Age of Accountability. *Educational Administration Quarterly*, 45(2), 168-216. doi:10.1177/0013161x08330499.

Daly, A. J. (2010). *Social network theory and educational change*. Cambridge, Mass: Harvard Education Press.

Daly, A. J. (2012). Data, dyads, and dissemination: Exploring data use and social networks in educational improvement. *Teachers College Record*, 114(11), 1-38.

Daly, A. J., & Finnigan, K. S. (2010). A bridge between worlds: understanding network structure to understand change strategy. *Journal of Educational Change*, 11(2), 111-138.
doi:10.1007/s10833-009-9102-5.

Daly, A. J., & Finnigan, K. S. (2011). The Ebb and Flow of Social Network Ties Between District Leaders Under High-Stakes Accountability. *American Educational Research Journal*, 48(1), 39-79. doi:10.3102/0002831210368990.

Daly, A. J., & Finnigan, K. S. (2012). Exploring the space between: Social networks, trust, and urban school district leaders. *Journal of School Leadership*, 22, 493-530.

Daly, A. J., Finnigan, K. S., Jordan, S., Moolenaar, N. M., & Che, J. (2014). Misalignment and Perverse Incentives. *Educational Policy*, 28(2), 145-174. doi:10.1177/0895904813513149.

Daly A. J., Liou Y., Tran N., Cornelissen F., Park V. (2013). The rise of neurotics: Social networks, leadership, and efficacy in district reform. *Educational Administration Quarterly*. Advance online publication. doi:10.1177/0013161X13492795.

Daly, A. J., Moolenaar, N. M., Bolivar, J. M., & Burke, P. (2010). Relationships in reform: the role of teachers' social networks. *Journal of Educational Administration*, 48(3), 359-391.
doi:10.1108/09578231011041062.

Daly, A. J., Moolenaar, N. M., Liou, Y., Tuytens, M., & Fresno, M. D. (2015). Why So Difficult? Exploring Negative Relationships between Educational Leaders: The Role of Trust, Climate, and Efficacy. *American Journal of Education*, 122(1), 1-38. doi:10.1086/683288.

Evers, A. T., Heijden, B. I., Kreijns, K., & Gerrichhauzen, J. T. (2011). Organisational factors and teachers' professional development in Dutch secondary schools. *Journal of European Industrial Training*, 35(1), 24-44. doi:10.1108/03090591111095727.

Farley-Ripple, E., & Buttram, J. (2015). The development of capacity for data use: The role of teacher networks in an elementary school. *Teachers College Record*, 117(4), 1-34.

Finnigan, K. S., & Daly, A. J. (2012). Mind the Gap: Organizational Learning and Improvement in an Underperforming Urban System. *American Journal of Education*, 119(1), 41-71.
doi:10.1086/667700.

Frank, K. A., Zhao, Y., Penuel, W. R., Ellefson, N., & Porter, S. (2011). Focus, Fiddle, and Friends. *Sociology of Education*, 84(2), 137-156. doi:10.1177/0038040711401812.

- Hanneman, R.A. & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California.
- Honig, M. (2008). District Central Offices as Learning Organizations: How Sociocultural and Organizational Learning Theories Elaborate District Central Office Administrators Participation in Teaching and Learning Improvement Efforts. *American Journal of Education*, 114(4), 627-664. doi:10.1086/589317.
- Hubbard, L., Mehan, H., & Stein, M. K. (2006). *Reform as learning: school reform, organizational culture and community politics in San Diego*. New York: Routledge.
- Kezar, A. (2014). Higher Education Change and Social Networks: A Review of Research. *The Journal of Higher Education*, 85(1), 91-125. doi:10.1353/jhe.2014.0003.
- Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Liou, Y.-H., & Daly, A.J. (2016). Diffusion of innovation: A social network and organizational learning approach to governance of a districtwide leadership team. *Pedagogía Social. Revista Interuniversitaria*, 28, 41-55. DOI:10.7179/PSRI_2016.28.04.
- Maele, D. V., & Houtte, M. V. (2009). Faculty Trust and Organizational School Characteristics: An Exploration Across Secondary Schools in Flanders. *Educational Administration Quarterly*, 45(4), 556-589. doi:10.1177/0013161x09335141.
- Maele, D. V., & Houtte, M. V. (2011). Collegial Trust and the Organizational Context of the Teacher Workplace: The Role of a Homogeneous Teachability Culture. *American Journal of Education*, 117(4), 437-464. doi:10.1086/660754.
- Maele, D. V., & Houtte, M. V. (2012). The role of teacher and faculty trust in forming teachers' job satisfaction: Do years of experience make a difference? *Teaching and Teacher Education*, 28(6), 879-889. doi:10.1016/j.tate.2012.04.001.
- Mamas, C. (2017). Exploring peer relationships, friendships and group work dynamics in higher education: applying social network analysis. *Journal of Further and Higher Education*, 1-16. doi:10.1080/0309877x.2017.1302568.
- Marsh, J. A. (2002). How districts relate to states, schools, and communities: A review of emerging literature. In A. M. Hightower, M. S. Knapp, J. A. Marsh, & M. W. McLaughlin (Eds.), *School districts and instructional renewal* (p. 25-40), New York: Teacher College, Columbia University.
- Moolenaar, N. M., Daly, A. J., & Slegers, P. J. (2010). Occupying the Principal Position: Examining Relationships Between Transformational Leadership, Social Network Position, and

- Schools' Innovative Climate. *Educational Administration Quarterly*, 46(5), 623-670. doi:10.1177/0013161x10378689.
- Moolenaar, N. M., & Slegers, P. J. (2014). The networked principal: Examining principals' social relationships and transformational leadership in school and district networks. *Journal of Educational Administration*, 53(1), 8-39. doi:10.1108/jea-02-2014-0031.
- Moolenaar, N. M., Slegers, P. J., & Daly, A. J. (2012). Teaming up: Linking collaboration networks, collective efficacy, and student achievement. *Teaching and Teacher Education*, 28(2), 251-262. doi:10.1016/j.tate.2011.10.001.
- Moolenaar, N. M., Slegers, P. J., Karsten, S., & Daly, A. J. (2012). The social fabric of elementary schools: a network typology of social interaction among teachers. *Educational Studies*, 38(4), 355-371. doi:10.1080/03055698.2011.643101.
- Penuel, W. R., Korbak, C., Sussex, W., Frank, K., & Belman, D. (2007). *Catalyzing network expertise: Year 1 report*. Menlo Park: SRI International.
- Penuel, W. R., Riel, M., Joshi, A., Pearlman, L., Kim, C. M., & Frank, K. A. (2010). The Alignment of the Informal and Formal Organizational Supports for Reform: Implications for Improving Teaching in Schools. *Educational Administration Quarterly*, 46(1), 57-95. doi:10.1177/1094670509353180.
- Penuel, W. R., Riel, M., Krause, A., & Frank, K. A. (2009). Analyzing teachers' professional interactions in a school as social capital: A social network approach. *Teachers College Record*, 111(1), 124-163.
- Penuel, W. R., Sun, M., Frank, K. A., & Gallagher, H. A. (2012). Using Social Network Analysis to Study How Collegial Interactions Can Augment Teacher Learning from External Professional Development. *American Journal of Education*, 119(1), 103-136. doi:10.1086/667756.
- Price, H. E. (2015). Principals' social interactions with teachers. *Journal of Educational Administration*, 53(1), 116-139. doi:10.1108/jea-02-2014-0023.
- Scott, J. (2011). *Social network analysis: a handbook*. London: Sage Publ.
- Smylie, M.A., Wenzel, S.A., & Fendt, C.R. (2003). The Chicago Annenberg Challenge: Lessons on leadership for school development. In J. Murphy & A. Datnow (Eds.), *Leadership lessons from comprehensive school reforms* (pp. 135-158). Thousand Oaks, CA: Corwin.
- Spillane, J. P., Hopkins, M., & Sweet, T. M. (2015). Intra- and Interschool Interactions about Instruction: Exploring the Conditions for Social Capital Development. *American Journal of Education*, 122(1), 71-110. doi:10.1086/683292.

Spillane, J. P., & Kim, C. M. (2012). An Exploratory Analysis of Formal School Leaders' Positioning in Instructional Advice and Information Networks in Elementary Schools. *American Journal of Education*, 119(1), 73-102. doi:10.1086/667755.

Spillane, J. P., Kim, C. M., & Frank, K. A. (2012). Instructional Advice and Information Providing and Receiving Behavior in Elementary Schools: Exploring Tie Formation as a Building Block in Social Capital Development. *American Educational Research Journal*, 49(6), 1112-1145. doi:10.3102/0002831212459339.

Stein, M., & Coburn, C. (2008). Architectures for Learning: A Comparative Analysis of Two Urban School Districts. *American Journal of Education*, 114(4), 583-626. doi:10.1086/589315.

Supovitz, J., Daly, A.J., del Fresno, M., & Kolouch, C. (2017). #commoncore Project. Retrieved from <http://www.hashtagcommoncore.com>.

Sun, M., Penuel, W. R., Frank, K. A., Gallagher, H. A., & Youngs, P. (2013). Shaping Professional Development to Promote the Diffusion of Instructional Expertise Among Teachers. *Educational Evaluation and Policy Analysis*, 35(3), 344-369. doi:10.3102/0162373713482763.

Tuomainen, J., Palonen, T. & Hakkarainen, K. (2010). A Special Education Teacher's Networks: A Finnish Case. *International Journal of Special Education*, 25(1), 46-58.

Tuomainen, J., Palonen, T., & Hakkarainen, K. (2012). Special Educators' Social Networks: A Multiple Case Study in a Finnish Part-time Special Education Context. *Scandinavian Journal of Educational Research*, 56(1), 21-38. doi:10.1080/00313831.2011.567394.

Waes, S. V., Moolenaar, N. M., Daly, A. J., Heldens, H. H., Donche, V., Petegem, P. V., & Bossche, P. V. (2016). The networked instructor: The quality of networks in different stages of professional development. *Teaching and Teacher Education*, 59, 295-308. doi:10.1016/j.tate.2016.05.022.

Appendix A. Studies included in the review

Author(s)	Year	Title	Journal
Baker-Doyle	2012	First-Year Teachers' Support Networks: Intentional Professional Networks and Diverse Professional Allies.	The New Educator
Baker-Doyle	2015	Stories in networks and networks in stories: a tri-modal model for mixed-methods social network research on teachers.	International Journal of Research & Method in Education
Baker-Doyle &	2011	In search of practitioner-based social capital: a	Professional

Yoon		social network analysis tool for understanding and facilitating teacher collaboration in a US-based STEM professional development program.	Development in Education
Coburn, Mata, & Choi	2013	The Embeddedness of Teachers' Social Networks.	Sociology of Education
Coburn & Russell	2008	District Policy and Teachers' Social Networks.	Educational Evaluation and Policy Analysis
Coburn, Russell, Kaufman & Stein	2012	Supporting Sustainability: Teachers' Advice Networks and Ambitious Instructional Reform.	American Journal of Education
Daly	2009	Rigid Response in an Age of Accountability.	Educational Administration Quarterly
Daly	2012	Data, dyads, and dissemination: Exploring data use and social networks in educational improvement.	Teachers College Record
Daly & Finnigan	2010	A bridge between worlds: understanding network structure to understand change strategy.	Journal of Educational Change
Daly & Finnigan	2011	The Ebb and Flow of Social Network Ties Between District Leaders Under High-Stakes Accountability.	American Educational Research Journal
Daly & Finnigan	2012	Exploring the space between: Social networks, trust, and urban school district leaders.	Journal of School Leadership
Daly, Finnigan, Jordan, Moolenaar & Che	2014	Misalignment and Perverse Incentives.	Educational Policy
Daly, Liou, Tran, Cornelissen & Park	2013	The rise of neurotics: Social networks, leadership, and efficacy in district reform.	Educational Administration Quarterly
Daly, Moolenaar, Bolivar & Burke	2010	Relationships in reform: the role of teachers' social networks.	Journal of Educational Administration
Daly, Moolenaar, Liou, Tuytens & Fresno	2015	Why So Difficult? Exploring Negative Relationships between Educational Leaders: The Role of Trust, Climate, and Efficacy.	American Journal of Education
Evers, Heijden, Kreijns & Gerrichhauzen	2011	Organisational factors and teachers' professional development in Dutch secondary schools.	Journal of European Industrial

			Training
Farley-Ripple & Buttram	2015	The development of capacity for data use: The role of teacher networks in an elementary school.	Teachers College Record
Finnigan & Daly	2012	Mind the Gap: Organizational Learning and Improvement in an Underperforming Urban System.	American Journal of Education
Frank, Zhao, Penuel, Ellefson & Porter	2011	Focus, Fiddle, and Friends.	Sociology of Education
Maele & Houtte	2009	Faculty Trust and Organizational School Characteristics: An Exploration Across Secondary Schools in Flanders.	Educational Administration Quarterly
Maele & Houtte	2011	Collegial Trust and the Organizational Context of the Teacher Workplace: The Role of a Homogeneous Teachability Culture.	American Journal of Education
Maele & Houtte	2012	The role of teacher and faculty trust in forming teachers' job satisfaction: Do years of experience make a difference?	Teaching and Teacher Education
Moolenaar, Slegers & Daly	2012	Teaming up: Linking collaboration networks, collective efficacy, and student achievement.	Teaching and Teacher Education
Moolenaar & Slegers	2014	The networked principal: Examining principals' social relationships and transformational leadership in school and district networks.	Journal of Educational Administration
Penuel, Riel, Krause & Frank	2009	Analyzing teachers' professional interactions in a school as social capital: A social network approach.	Teachers College Record
Penuel, Riel, Joshi, Pearlman, Kim & Frank	2010	The Alignment of the Informal and Formal Organizational Supports for Reform: Implications for Improving Teaching in Schools.	Educational Administration Quarterly
Penuel, Sun, Frank & Gallagher	2012	Using Social Network Analysis to Study How Collegial Interactions Can Augment Teacher Learning from External Professional Development.	American Journal of Education
Price	2015	Principals' social interactions with teachers.	Journal of Educational Administration
Spillane & Kim	2012	An Exploratory Analysis of Formal School Leaders' Positioning in Instructional Advice and Information Networks in Elementary Schools.	American Journal of Education
Spillane, Hopkins & Sweet	2015	Intra- and Interschool Interactions about Instruction: Exploring the Conditions for Social	American Journal of

		Capital Development.	Education
Spillane, Kim & Frank	2012	Instructional Advice and Information Providing and Receiving Behavior in Elementary Schools: Exploring Tie Formation as a Building Block in Social Capital Development.	American Educational Research Journal
Stein & Coburn	2008	Architectures for Learning: A Comparative Analysis of Two Urban School Districts.	American Journal of Education
Sun, Penuel, Frank, Gallagher & Youngs	2013	Shaping Professional Development to Promote the Diffusion of Instructional Expertise Among Teachers.	Educational Evaluation and Policy Analysis
Tuomainen, Palonen & Hakkarainen	2010	A Special Education Teacher's Networks: A Finnish Case.	International Journal of Special Education
Tuomainen, Palonen & Hakkarainen	2012	Special Educators' Social Networks: A Multiple Case Study in a Finnish Part-time Special Education Context.	Scandinavian Journal of Educational Research