Poulsen, T., Leary, H., Whiting, E. F., & Sansom, R. (2024). Social network analysis of educators in rural schools: A literature review. *Educational Research: Theory and Practice, 35*(4), 30-48.

Social Network Analysis of Educators in Rural Schools: A Literature Review

Tracy Poulsen, Heather Leary, Erin Feinauer Whiting, and Rebecca Sansom

Brigham Young University USA

Author Note

Rebecca Sansom is now at Texas A&M University.

Abstract: *Social network theory posits that social interactions provide access to information and other resources but may also constrain opportunities. Although social networks have been analyzed in educational settings to evaluate the effectiveness of interventions and the structures supporting or constraining educators, few studies address how social network analysis (SNA) has been utilized in rural settings. A review of the literature on social networks in rural schools among teachers and/or administrators indicates there is little research on the ties among rural educators, with a frequent assumption of no networking opportunities. Although similar attributes and proximity are frequently uncovered as predictors of tie formation in traditional SNA, in rural spaces these attributes are often intentionally utilized to structure effective networking and professional development. Studies within a school or district differed from studies between schools or districts. Due to the unique characteristics of rural settings, researchers should consider using ego-network studies or expanding defined boundaries of social networks to develop a clearer picture of the networks that provide opportunities or constrain rural educators.*

INTRODUCTION

Teacher effectiveness may be developed through many different avenues. The unique skills and attributes of a teacher are typically the area of discussion when describing high-quality teachers. Indeed, teacher quality may be the biggest single predictor of student learning and achievement (Goldhaber, 2016). However, this simplistic view ignores important factors of teacher improvement and practice. The movement of knowledge, expertise, and feedback through social ties (Coleman, 1998), has a potentially understated influence on an individual teacher's personal and professional development. This literature review explores the professional networks among rural educators.

The interactions between educators can have a profound effect on student outcomes. In a quantitative, longitudinal study of elementary school teachers and student data, Jackson and Bruegmann (2009) found that students had greater achievement gains in math and reading when

Correspondence concerning this article should be addressed to Rebecca Sansom, E-mail: rebecca.sansom@tamu.edu

teachers had more effective colleagues. Although this study did not determine the causal relationship between these variables, the authors suggest that the most likely mechanism for the finding is that teachers are learning directly or indirectly from their peers. Other studies indicate that the important practices of focusing on student learning, critical reflection, and sharing suggestions can result in increased knowledge of what affects student learning, more effective use of a variety of teaching strategies, and increased teacher self-efficacy (Darling-Hammond & Richardson, 2009; Lysberg, 2023).

Increased collaboration among rural educators may help teachers respond to some of the unique challenges of working in a rural school. Rural teachers frequently take on additional roles within their schools (Berry & Gravelle, 2013) in addition to teaching a greater variety of subjects, often outside of their field of study (Biddle & Azano, 2016). Additionally, rural educators often face severe social, physical, professional, and psychological isolation (Antilla & Väänänen, 2013). These challenges can be overwhelming, which may be partly to blame for the high rate of rural teacher turnover (Carver-Thomas & Darling-Hammond, 2017) as teacher retention is largely related to the level of support teachers receive in their first five years of teaching (Sabina et al., 2023). When surveyed, most rural principals and teachers felt that greater collaboration would have a major impact on student achievement (MetLife & Harris Interactive, 2013), but rural teachers frequently remain disconnected and isolated from other practitioners in their fields (Woodland & Mazur, 2019).

Teacher networks that support meaningful professional relationships tend to improve teaching and learning and make change efforts more effective (Daly, 2010). Given that rural teachers tend to place more value in their relationships with students, coworkers, and the community (Trentham & Schaer, 1985), understanding the relationships among rural teachers and administrators is important in supporting these teachers. This literature review describes the networks of teachers and administrators in rural spaces and describes what we currently know about networks based on the literature about SNA in rural schools.

BACKGROUND

Social network analysis (SNA) is a growing field of study in education and has been used to study the interactions of students, teachers, administrators, and university professors in a variety of contexts (e.g., Cela et al., 2015; Baker-Doyle & Yoon, 2020; Kezar, 2014). SNA provides a way to describe and measure the potential for the transfer of information, skills, and other resources (Daly, 2012), but is rarely used to describe education in rural settings (Woodland & Mazur, 2019).

Researchers and program facilitators have been using SNA data in educational settings in a variety of ways. For example, Baker-Doyle and Yoon (2011) found that teachers in urban schools frequently did not effectively network with others who had high levels of practitioner-based social capital, such as effective pedagogy, connections with resources, and the ability to provide support. By better understanding existing network structures, administrators and program facilitators could design collaborative and networking opportunities that utilized the strengths of various educators in each network. Additionally, administrators and policymakers can better plan to support rural teachers by understanding the contextual factors (e.g., geographic location, participation in professional development, subjects taught, etc.) that affect the formation of ties and the transfer of resources and support (Spillane et al., 2017). SNA can also be used to provide insight into barriers to participation in available professional learning opportunities (Bigsby & Firestone, 2017).

Most social network analyses in education have been conducted in urban, suburban, higher education, or social media settings. Literature reviews of social network analysis in various educational settings have been conducted and provide some insights into how it may be understood and utilized in rural spaces. In a literature review of seven studies of K-12 teachers, Baker-Doyle and Yoon (2020) identified several themes that support increasing the use of SNA in analyzing teacher networks and teacher development. The study highlighted the importance of building trusting relationships, designing structural supports, identifying and assigning teacher leaders, and enabling training opportunities intentionally focused on relevant issues.

In a literature review of SNA in higher education, Kezar (2014) argued that social network analysis was well-suited to examine organizational and educational change by looking at how ideas, resources, and information flow in higher education. The author further articulated many implications of how SNA should be used in higher education. For example, because colleges are typically spread out across campuses, there is little opportunity for inter-college communication and collaboration, implying that SNA research should look at not only in-campus connections but also professional organizations and online communities of practice. The few opportunities to interact with other colleges may suggest that similar findings may be true about the connections between educators in other settings, including rural teachers.

Although the insights gained from this research are valuable, some researchers have argued that research in rural settings has different political and methodological challenges (Biddle & Azano, 2016). These differences may require researchers to rethink how they conduct research in rural space and consider that rural settings are not only geographically defined but also demographically and culturally defined (Roberts & Green, 2013). Rural areas are frequently viewed as resource-deficient and can be classified as having a lower socioeconomic status just as some urban areas do. However, differences in rural culture and organization should perhaps result in researchers characterizing and studying rural spaces on their own merits (Roberts & Green, 2013). The diversity of findings in the literature reviews described above indicates that the context of the study is important to consider when conducting social network analysis studies. Although there may be some transfer of findings, understanding the rural context may affect the use and interpretations of social network analysis in this context.

The literature reviews of SNA in these different educational settings have facilitated a deeper understanding of how ideas, information, and resources are transferred between educators (e.g., Kezar, 2014; Manning, 2017; Ouyang & Scharber, 2017; Saqr et al, 2018). SNA provides a way to study and further understand the connections between educators that influence their retention, professional development, and support networks. This information may be particularly applicable to understanding and addressing the extenuating struggles of rural teachers and administrators such as the lack of teacher retention, lack of professional network and professional development opportunities, and increased need for structural support (Woodland & Mazur, 2018). Due to the unique challenges of rural teachers and administrators, a similar literature review of rural educational settings may provide necessary background information for implementing this type of analysis in rural spaces.

This literature review builds upon prior research in educational SNA by addressing the following questions:

1. How is SNA used to research rural schools, including such characteristics as the assumption of ties present; homophily, propinquity, and trust in tie formation; and organizational structural factors affecting the establishment of ties?

2. What characteristics of rural settings affect how SNA can be used and analyzed in rural spaces?

First, we will provide an overview of the theoretical framework and methods used in social network analysis in rural education. Then we will explore how these facets appear in the literature of rural social network research.

THEORETICAL FRAMEWORK

SNA has been utilized for almost 100 years in various fields, such as economics, politics, business, and medicine (Aydin, 2018; Borgatti et al., 2009). Its extensive use is built around social capital theory. Social capital theory "contends that social relationships are resources that can lead to the development and accumulation of human capital" (Machalek & Martin, 2015, p.897). Three primary assumptions guide social network and social capital theory including the assumption that (a) people exchange resources with others with whom they have a relationship, (b) people within a network are interdependent rather than independent, and (c) social connections can both inhibit and/or provide opportunities and support for actions and change (Broda et al., 2018). When educators have opportunities to build supportive relationships with others, they increase their ability to access the expertise of others.

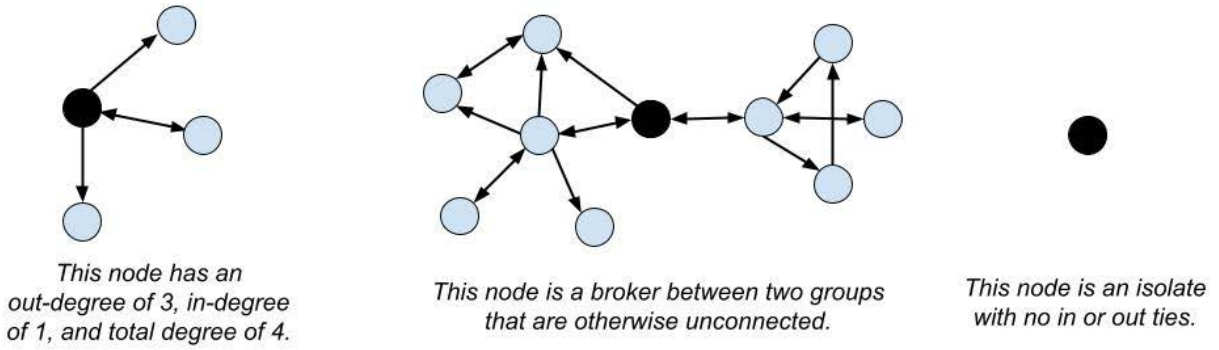
Many statistical methods of analysis rely on the assumption that variables and people under study are independent of each other. Social network analysis assumes the opposite. A generic hypothesis of network theory is that the relationships between actors (such as teachers and administrators) in the network determine the opportunities and constraints available to each actor (Borgatti et al., 2018).

Social network analysis (SNA) studies the interactions among individuals or groups. Networks characterize social systems by defining individual actors (nodes) and the interactions among them (ties). Regardless of the field of study, there are several patterns identified in the ties between the actors under study. Attributes of nodes can be used to predict the likelihood of tie formation and the strength of ties in the network. Two attributes that tend to be strongly predictive of tie formation within a network are homophily and propinquity. Homophily means that nodes with similar attributes (such as race, gender, interests, or position) are more likely to form ties and share information (McPherson et al., 2001). Propinquity describes the pattern that nodes that are physically closer together, such as on the same hallway or floor, are more likely to form ties and share information (Monge et al., 1985; Spillane et al., 2017).

The types of ties are frequently placed into two general categories: expressive ties and instrumental ties. Expressive ties, such as friendship and trust, tend to be concerned with affective qualities and be resilient (Borgatti et al., 2018). On the other hand, instrumental ties are goal-oriented or work-related, such as advice-seeking ties, and can be more effective in the transfer of information (Borgatti et al., 2018). The type of tie present can have different influences on the transfer of educational practices. For example, teachers may be friends but not have meaningful conversations about teaching and learning (Burton et al, 2013). Stronger ties form when both expressive and instrumental interactions occur between two nodes and with an increased frequency of interaction between the nodes. (Borgatti et al., 2018).

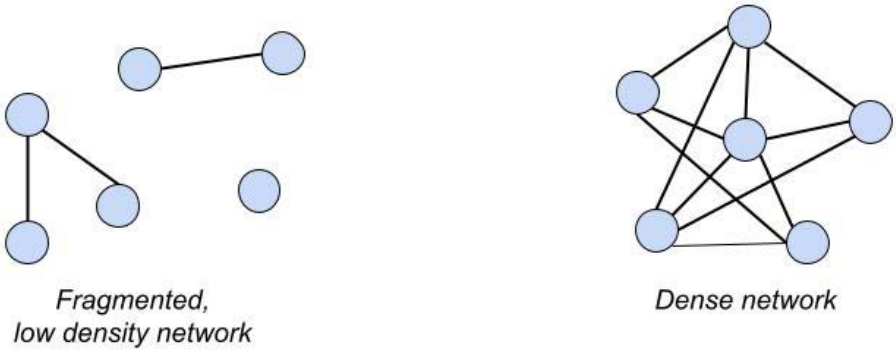
Centrality describes a node's placement or potential power in a network and can be measured in various ways. In the studies analyzed here, the most frequent measure of centrality was degree-centrality (see Figure 1), or the number of ties to each node in the network (Borgatti et al., 2018). Nodes with high centrality are presumed to have a higher likelihood of information flowing through them in the network. Some nodes have no ties (degree centrality = 0) and are called isolates. A node that is connected to groups that would otherwise be unconnected, called a broker, has the potential to facilitate the transfer of information or resources between groups.

Figure 1
Node Centrality



The centrality measures described above are node-level descriptors. In other words, each node (teacher or administrator) has its own value for each of these characteristics. However, other measures are used to describe the overall network if the study describes a bounded network. Density (see Figure 2) is the ratio of the ties observed in the network compared to the total number of possible ties. In a network in which each node is tied to each other node, the density would be one and information would be more likely to travel to each node in the network. On the other hand, networks that are disconnected (density close to zero) or that include many isolates are ineffective at transferring and sharing information (Woodland & Mazur, 2018).

Figure 2
Network densities



METHODS

In this systematic literature review, we sought out research that explores the social networks of professional interactions of rural educators. We included those that described the collaboration and advice-seeking interactions between educators in rural spaces. Although SNA has also been used to analyze interactions in social network platforms (such as Twitter, Facebook, and Instagram), our focus is on the collaborative interactions between teachers outside of social media.

Because the research questions focused specifically on rural schools, we searched databases that were most likely to include education settings including EBSCO (ERIC), APA

Psych Info, ProQuest (Social Science Collection), and Academic Search Ultimate. Results were analyzed for duplicates in Zotero. The search criteria are summarized in Table 1.

Table 1
Database Search Terms

Database	Search Terms
ERIC (EBSCO)	"Social network analysis" or DE Network analysis or DE social network AND DE rural schools or DE rural education or DE urban rural differences
APA Psych Info	DE social network analysis AND DE academic environment or DE rural environments
Academic Search Ultimate	DE social network analysis AND DE Rural schools
Google Scholar	"Social network analysis" AND "Rural schools"

Note: DE indicates a thesaurus term in the respective database.

From these initial search results of articles (N=95), titles and key terms were initially analyzed for applicability for this study. Because this study addresses the interactions and collaboration between rural teachers and administrators, articles were eliminated that researched only social media spaces (e.g., Twitter, Instagram, or marketed collections of teacher materials). Studies of student, university faculty, or community-based social networks were also eliminated, retaining studies that focused on K-12 teachers and administrators. The remaining articles (N=30) were read resulting in the further elimination of fourteen additional articles due to not fitting the criteria (e.g., focus on implementation of technology structure but no description of the teacher or administration networks). Due to the limited number of applicable articles, we extended our review to include Google Scholar identifying two additional studies among the first 100 search results. We also reviewed references of articles to identify other articles that may fit the criteria, resulting in the inclusion of two additional articles. Articles included in the analysis are marked with an asterisk in the references list.

Included articles (n=20) were categorized based on the method of study (i.e., quantitative, qualitative, or mixed method) and whether the article described educator networks within the same school (intraschool) or between schools (interschool). Articles were additionally categorized for characteristics essential for understanding SNA, including direct or indirect references to propinquity, homophily, trust, organizational and leadership effects, and rural-context issues. For example, although few articles explicitly used the term homophily, most of the articles described connections formed due to common characteristics of the teachers (e.g., both teach the same subject or interest in common learning outcomes). Additionally, few articles directly used the terms propinquity or proximity but implicitly referred to these ideas such as having neighboring

classrooms or being in the same wing of a school. Areas of categorization, such as homophily and propinquity, were primarily identified a priori, based on common concepts addressed in social network studies.

Following the classification, we identified themes emerging from the data which were further understood in light of prior research regarding rural education and social network analysis. All of the articles were analyzed primarily by the first author to determine categorizations and to identify emergent themes. The authors met regularly for peer debriefing to discuss both categorizations and themes and come to a consensus if there were any discrepancies.

FINDINGS

The analysis of the studies provides insight into how the theoretical assumptions, methods of study, and results in rural schools are similar and different when compared to other educational settings. Table 2 summarizes the thematic patterns identified in the articles. The findings suggest that SNA is infrequently used in rural educational settings despite the relative importance of attending to social capital resources in these settings. Additionally, whether the study was conducted within a school or district or between different schools and districts affected the social network theory assumption of ties existing between actors and how homophily and propinquity were viewed or utilized. Trust and expressive ties and organizational support, such as administrative policies, played a role in the development and maintenance of ties between educators in these studies.

FREQUENCY OF RURAL SNA EDUCATION STUDIES

Social network analysis is an underutilized tool in studying the interactions and networks of rural teachers and administrators. All but three of the studies were published post 2002, indicating that this is a new and still growing field of study in rural education. One of the powerful tools of SNA is the ability to quantitatively measure node and network attributes (Borgatti et al., 2018). Although almost half of the articles specifically referred to social network analysis and/or social capital, few articles used quantitative SNA metrics in their study (e.g., Karnopp, 2022a; Karnopp & Bjorklund, 2022; Woodland & Mazur, 2019). Several studies discussed SNA but used only qualitative data in their analysis (e.g., Forfang, 2021; Hargreaves et al., 2015). Lack of the inclusion of quantitative measures of SNA reduces researchers' ability to describe important features of the network structure and positions of the individual actors which affect their access to social capital through their connections. Most studies reviewed relied heavily on qualitative data, which perhaps gives a deeper understanding of the experiences of the rural teachers and administrators being studied, but limits researchers' ability to generalize findings to other rural spaces (Queirós et al., 2017). The limited use of quantitative aspects of SNA research may be due in part to the small nature of rural schools, with fewer nodes to measure, reducing statistical power in analysis or failure to define an appropriate boundary necessary for global-network analysis.

Table 2
Classification of Articles

Characteristic	Presence in Article	Number of Articles
Reference to social network analysis	Explicit	11
	Implicit	9
Reference to homophily	Explicit	1
	Implicit	17
	Not discussed	2
Reference to propinquity	Explicit	2
	Implicit	15
	Not discussed	3
Reference to trust	Explicit	13
	Implicit	6
	Not discussed	1
Reference to rural context factors	Explicit	14
	Implicit	2
	Not discussed	4
Population	Teachers Only	9
	Administrators Only	6
	Both Teachers and Administrators	5
Boundary	Intra (within school or district)	7
	Inter (between schools and/or districts)	9
	Mix of intra and inter	4
Research Method	Quantitative	3
	Qualitative	8
	Mixed Method	9
In-person Components	Yes	18
	No	2

The Assumption of Existing Ties

SNA can be used to study two different types of general questions: what influences the formation of ties and how those ties shape particular outcomes for the network or individuals (Grunspan et al., 2014). Both rely on the foundational assumption that there are ties between nodes or actors. This foundational assumption was treated differently in interschool and intraschool connections. In particular, studies of the interschool/district connections contradict the primary assumption of ties between educators. There were frequent references regarding the isolation of teachers and administrators in which there were fewer opportunities for connections (e.g., Allen

& Topolka-Jorissen, 2014; Edwards, 2019; Hargreaves et al., 2015). Two studies described the importance of networking between administrators in the success of their rural schools (e.g., Forfang, 2021; Garber, 1993). Most other studies described the lack of ties between teachers and/or administrators as one of the prime purposes for an intervention aimed at increasing access to and the strength of supportive networks. Howley et al., (2002) studied isolated, early career administrators who were placed into mentor/mentee relationships with more experienced administrators. Hite, et al. (2010) suggested that by increasing the connections of rural principals, isolated teachers may have the opportunity to form connections with other teachers in similar circumstances, but no data was given to indicate whether this intended outcome was observed.

The Role of Trust

Trust is an important component of strong expressive relationships. All but two studies indicated the importance of forming trusting relationships between teachers and/or administrators (Garber, 1993; NASDSC, 1990). Trusting relationships played a significant role in the perceived success of interdistrict collaboration and networking. Forfang (2021) utilized interview data, Likert scaled survey items, and analysis of policy documents to identify attributes of a network of consistently higher performing rural schools in England. The student success observed was strongly attributed to the formal (e.g., structures and routines) and informal (e.g., mutual accountability and common goals) connections between school leaders that allows for greater utilization of materials, expertise, and other resources. Hite et al., (2010) reiterated this claim, suggesting that it would be advantageous to rural districts to "create, manage and enhance cross-district networks" to alleviate some of the burdens caused by the common lack of resources in rural schools.

When new interventions were implemented in schools or districts, trust played a significant role in their success at multiple levels. The pre-existence of trusting relationships was important for recruitment (Hargreaves et al., 2015). Additionally, teachers and administrators were likely to turn to previous trusting relationships more than outside experts when questions arose about implementation of technology (Karnopp, 2022a). Successful interventions also fostered the development of trusting relationships between teachers and administrators participating in the intervention (e.g., Allen & Topolka-Jorissen, 2014; Edwards, 2019; Reading, 2010).

Three studies described intervention programs to support rural principals through professional development and through providing experienced peers to serve as mentors to new administrators (Hite et al. 2010; Howley et al., 2002; Wells et al.; 2021). Each study described the importance of mentors and mentees forming trusting relationships which allowed open communication and common goal settings. In successful connections, mentees were able to be vulnerable and ask for advice and mentors were able to discuss difficult topics. In survey data and interviews, mentees indicated the importance of frequent in-person communication with mentors that had experience facing the challenges of rural schools in developing a trusting relationship, a necessary component of accessing human capital.

In developing trust, most authors recognized the importance of in-person communication for developing meaningful, supportive relationships. All but two (Dailey, 2017; Reading, 2010) of the studies incorporated in-person communication as an intentional part of their study design or population of study. Technology supporting other forms of collaboration and communication (e.g., telephone, email, video conferencing) was sometimes used in addition to the in-person components. Although geographic distances create significant barriers to in-person communication, Reading (2010), who studied exclusively online spaces, highlighted the

importance of synchronous online interactions between teachers. In two studies of less effective networking (Aston & Hyle, 1997; Mania et al., 2022), researchers indicated that the lack of trusting relationships was detrimental to development of the desired support networks.

HOMOPHILY AND PROPINQUITY

Rural educator networks within schools (intraschool) uncovered elements of propinquity and homophily similar to nonrural SNA teacher studies (e.g., Bristol & Shirrell, 2019; Coburn et al., 2012). As opposed to the natural formation of ties, interschool/district studies typically intentionally utilized homophily and propinquity in interventions to facilitate the formation of groups.

Homophily is the tendency of teachers and administrators with similar attributes to form ties. Collaboration typically occurs between those who have similar thoughts and beliefs (Aston & Hyle, 1997). Mania et al. (2022) and Karnopp (2022b) both found that, without intervention, ties between same-subject or same-grade teachers were much more likely to form than ties that spanned across subjects or grades. Teachers had the highest in- and out-degree with others who taught in their same grade-levels, placed within the same hallway in the school (Mania et al., 2022) and more interactions were reported between same grade teachers (Karnopp, 2022b). Teachers were also more likely to form ties with others who were in the same life stage (early, middle, and veteran) of their careers (Karnopp & Bjorklund, 2022). Mania et al. (2022) found similar trends where four veteran teachers were not only located at the same end of the hallway, but also shared close personal ties outside of the school. Although race-homophily is common in SNA studies, both inside and outside of education (Karnopp & Bjorklund, 2022), no rural studies tested this due to insignificant racial diversity in populations under study. Because 90% of rural teachers in the United States are white (Schaeffer, 2021), this lack of diversity of the populations in these studies is consistent with national trends.

Homophily can also be described as having common interests and goals. Some of the networks described in these studies were formed based on their similarities alone, identifying a population with similarities in attitude as the boundary of their study. For example, Edwards (2019) studied secondary teachers that participated in summer institutes with continued opportunities for virtual network activities. The author reported that teachers appreciated having the opportunity to work with others who shared a common interest and had a desire to learn from each other. Furthermore, the continued use of virtual discussions allowed teachers to focus on specific subtopics of interest. In a social network analysis study by Karnopp and Bjorklund (2021), the researchers found that in both rural and urban schools, secondary teachers were more likely to form friendship ties with other teachers that were in the same phase (early career, midcareer, and veteran career), particularly for early career teachers. In comparing the school climate of two demographically similar rural elementary schools with but differing in the level of promotion of teacher collaboration and diversity, Aston and Hyle (1997) used interview and observational data to describe the interactions between teachers and administrators. They found that teachers collaborated with those who have similar thoughts and beliefs (same grade level or subject) with little collaboration outside of their grade-level teams. Rural teachers and leaders of the same subject, phase of life, interests, and goals are more likely to form ties with each other.

Homophily can potentially be a barrier to the transmission of new ideas between teachers. Woodland (2019) cautioned that when teachers only form connections with other like-minded teachers, no new ideas are generated. Similar to more traditional SNA studies in education (e.g., Maher & Prescott, 2017; Monge et al., 1985), without structures in place to support and maintain

network formation, ties formed between teachers were more strongly correlated with homophily and propinquity rather than expertise. Especially when opportunities to form ties with other same-grade or same-subject teachers are limited, administrators should consider how to foster the development of ties between teachers of different grade levels or subjects. Teachers have the potential to learn a lot from others and access their social capital within their school regardless of whether they teach the same subject (Allen & Topolka-Jorissen, 2014; Aston & Hyle, 1997).

Woodland and Mazur (2019) studied the result of an intervention to form more professional learning communities (PLCs) between teachers in rural schools. The administrators and researchers intentionally sought to develop networking among teachers by placing them in diverse collaborative groups within and between neighboring schools. These mixed groups provided teachers with the opportunity to connect with other teachers and experts within the school and learn from others whom they would unlikely have connected with outside of these formal PLCs.

Another study explored the effect of learning teacher-walks in a rural school (Allen & Topolka-Jorissen, 2014). In this study, teachers informally observed their colleagues' instructional practices, looking for ways to adapt effective pedagogy into their own classrooms. The school under study was small and contained many singleton teachers (teachers that are the only teacher of their subject or grade in a school). The authors found that teachers benefited through increased observation, discussion, and collaboration between teachers of different grade-levels and subjects. In this school of 19 teachers, teachers initially had few connections with others, especially outside of their grade level or the hall in which their classrooms were located. Teachers were able to build strong ties despite these differences due to having shared ownership of the community and students. Teachers who participated in the learning teacher-walks interacted more frequently and with a wider variety of teachers throughout the building. Through careful implementation by administrators and other leaders, teachers were able to overcome some of the limitations of ties formed exclusively through homophily and propinquity.

Geographical propinquity, the tendency to form ties with those who are in proximity, is also prevalent within rural schools. In a study of a small, rural school in the Eastern United States, teachers and staff treated different areas within the school as separate programs in the school, with little overlap (Allen & Topolka-Jorissen, 2014). Similarly, Karnopp (2022b) found that ties between teachers were more likely to form with those that had classrooms right next door to each other, the same lunch period, or when collecting materials and resources from common areas. Mania et al., (2022) also substantiated this finding with teachers reporting the strongest advice connections with their closet-buddies, where two classrooms were joined by a shared storage space.

For geographically isolated connections, such as interdistrict connections, homophily was frequently utilized by those organizing interventions as a tool in the formation of groups and ties, rather than a natural occurrence. Similarities between teachers and school culture are frequently used in rural spaces to place isolated teachers and administrators in groups where they are more likely to have a stronger sense of belonging. Augustine-Shaw (2016) and Wells et al. (2021) intentionally paired administrators with similar backgrounds, district demographics, and geographic location to foster relationship building. This intentional pairing was important to allow important in-person observations and conversations to occur. In this study, the relatively short geographic distances between rural schools were also hypothesized to contribute to the strong relationships developed between administrators (Forfang, 2021). Similarly, interventions for teachers typically placed teachers in groups with others in similar positions or teaching assignments. Teachers (Hargreaves, 2015) and administrators (Howley, 2002) both expressed that

having the opportunity to discuss common issues was extremely valuable. Similarly, Reading (2010) noted the importance of frequent interaction between like-minded teachers in developing collaborative relationships. When there were large distances between rural schools, ties were formed as a result of participation in professional learning opportunities with sustained components of virtual communication (Edwards, 2019; Hargreaves et al., 2015).

FORMAL ORGANIZATION OF NETWORKS

Most studies (N=12) highlighted the importance of rural administrators and other leaders in organizing and facilitating formal administrative- and teacher-level networks. For example, Muijs (2015) used mixed methods to study the effect of administrators in building such a collaborative network among rural schools (explaining between 30.6 and 37.0% of the variance observed) and student-level standardized testing results (explaining between 10.4 and 13.8% of the variance observed) when controlling for socioeconomic status, ethnicity, and prior academic achievement. Due to geographic barriers, many of the support connections made between teachers and administrators were unlikely to form without the structural support created through the development and facilitation of the federation by rural administrative leaders.

The potential for administrators to enact changes to the collaborative social networks of teachers and staff was also explored by Woodland and Mazur (2019). In this mixed methods study, the professional social networks of teachers and administrators participating in professional learning communities (PLCs) of four elementary schools in the Northeastern United States were studied prior to, during, and after integrating a 3-year PLC initiative. Although each school increased the number of formal PLC teams present in the school, they did not result in the same observed effects in the social network structure. One of the three schools studied saw a dramatic increase in density (from 0.05 to 0.35 over three years) and decrease in isolates (those with no in- or out-ties, decreased from 18 to 4). The second school observed little change in density (0.52 to 0.53) with decreasing isolates (from 12 to zero). The role of the principal also differed by the school, in which the principal was an active participant in collaborative groups in some schools and remaining separate in one school. In the schools with the principal actively being a part of the collaborative structure, the networks became more connected over time. No change in network capacity was seen in the school where the principal remained isolated from the school's collaborative structure. In other studies which reported positive changes in the network through the implementation of structured support systems, rural administrators frequently were the central hub in a hub and spoke network structure (see Figure 3), in which the principal is connected to many others who were otherwise unconnected to teach other (e.g., Wells et al, 2021; Woodland & Mazur, 2019).

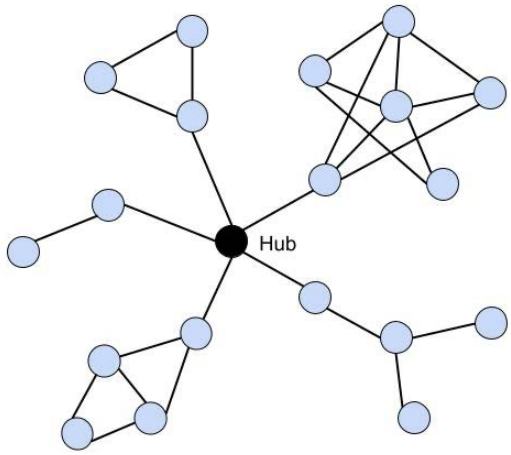
The important role administrators foster in developing effective relationships was discussed in other articles, as well. Additional formal support was especially important in the initial stages of the implementation of a networking intervention coupled with a gradual reduction in scaffolding (Hargreaves et al., 2015). Important structural components included a dedicated time for teacher or administrator reflection and discussion (Garber 1993; Howley et al., 2002), organizational structure (e.g., collaboration teams) (Mania et al., 2022; Karnopp, 2020a), and an environment in which teachers or administrators would want to participate whether or not participation was voluntary or compulsory (Hargreaves et al., 2015; Dailey, 2017; Woodland & Mazur, 2019). For isolated, rural teachers, technology may serve as a tool for structuring supportive networks between teachers and administrators (Dailey, 2017; Reading, 2010). When

building supportive networks between teachers, it is important for administrators to recognize and utilize the network structure that is already in place (Karnopp, 2022b).

From this systematic review, it is clear that without rigorous structure in place to support collaboration and networking, teachers are most likely to fall back to small, isolated groups regardless of the expertise of the other connections (Karnopp, 2022a; Karnopp, 2022b). When leaders were engaged in professional development, they were unlikely to share their expertise with those outside of their small networks without a formal structure for sharing and support in place (Mania et al., 2022).

Figure 3

Hub and Spoke Network



Hub and spoke network pattern

CONCLUSION

Rural teachers face many challenges that may be better understood by understanding the supportive networks that exist among teachers, administrators, and resources in rural spaces. These findings indicate that social network analysis is underutilized in rural spaces but may be a valuable tool for understanding the networks that exist. Although SNA studies within rural schools are conducted similarly to more urban school settings, differences in the assumptions made regarding the existence of ties and the roles of trust, homophily, and propinquity in tie formation differed when studying interschool or district connections. These connections may become even more important when studying singleton teachers or small, rural schools. Rather than homophily and propinquity being used to explain the formation of existing ties, in interschool connections, they are used as a tool to place educators into groups with the hopes of establishing stronger ties. Additionally, the research emphasizes the role that administrators play in helping establish and maintain networks between educators and that the presence of a formal structure for collaboration is needed for networks to maintain connectedness.

Research in social networks suggests that the informal connections among actors (such as teachers or administrators) often play the biggest role in producing and sustaining change in education, beyond what is possible through formal networks and roles alone (Daly, 2010). This may be especially true of rural educators who are frequently resistant to pressures to change by those outside of their communities (Burton et al., 2013). Because opportunities to build formal

networks may be very limited, access to informal networks may be especially valuable. This valuable information could be used to address some of the barriers unique to rural educators. By understanding the opportunities to develop supportive networks, researchers and administrators could use the information gained through social network data in planning and implementing collaboration or professional development opportunities. Additionally, this data could provide insight into why interventions are not being implemented effectively and where more support is needed, leading to the overall improvement of rural education.

Many of these rural studies emphasized the isolation of rural teachers. This isolation can result in the misleading assumption that rural teachers have no network at all. Perhaps, instead, their networks are defined more broadly than is traditionally defined in more typical bounded SNA studies. Studying SNA in higher education, Kezar (2014) recommended expanding traditional networks that only include those working in the same campus to other connections such as online collaborative opportunities, participation in professional organizations, and connections within the broader community. Kezar (2014) also indicated that faculty members benefited from interacting with faculty at other institutes of higher education implementing change in their practices. Because rural teachers typically have fewer opportunities for connections within their own schools, they may also benefit from extending their networks outside of school or district defined boundaries. Rural educators may be very isolated, in terms of their access to professional collaborators with similar job descriptors and responsibilities. However, they may have other resources for support and development which they rely on such as professional organizations, professional development opportunities outside of the school or district, and networking with community, family, or other organizations. Social network analysis studies could be expanded to explore these other areas as well, such as through ego-network studies of professional, community, social, or other ties.

Different rural areas face different constraints and access to support. Teachers in rural schools which are also a large distance from any urban hub, classified as Frontier and Remote (FAR), face increased geographic barriers that are not as easily overcome through in person network development (USDA, n.d.). These teachers and administrators are even less likely to have the opportunity to develop meaningful connections, and perhaps have an even greater need for opportunities for organizational structured connections. Much of the research presented here described the importance of rural educators being able to form in-person connections with other rural educators. Additionally, interventions typically used relatively short geographic distances as a criterion of pairing of mentors and mentees. For FAR educators, this may not be as feasible.

Studies of interventions intended to increase teacher collaboration give hope that online and digital spaces may provide a way to bring teachers together for meaningful collaboration. Building on the importance of trust, effective networking is more likely to utilize synchronous digital components (i.e., video conferencing) that allow for some of the same relationship development that occur during in-person interactions (Li & Krasney, 2021; Reading, 2010). Additionally, online learning or collaboration spaces need to be structured in a way in which teachers build relationships with each other, not just the facilitator (Kale et al., 2011; Li & Krasney 2020). Technology may provide a tool through which FAR educators may be able to connect with others in a synchronous, trusting, frequent, and supportive manner. More research is needed to understand how technology may be utilized in facilitating the development of the social networks of these educators.

It is also important to recognize the role of organizational structures to support the formation of ties. Through formal networks, educators were given access to colleagues and expertise that they otherwise would not have access to (Augustine-Shaw, 2015). Where

administrators had higher rates of effective collaboration, students performed better, and teachers were provided with resources and support frequently limited in rural schools (Forfang, 2021). Policymakers and leaders can leverage social network analysis data to better understand the structure of their networks and create opportunities to facilitate network development or to evaluate the effectiveness of implemented programs. For example, for loosely connected networks, administrators should set aside time for frequent collaboration and the resources that may be needed to overcome distance barriers. In contrast, if the network is found to have a hub-and-spoke pattern, administrators may want to consider changes that would allow skills, information, and expertise to flow through the network without having to move through the hub.

Limitations and Suggestions for Further Study

Although SNA provides a way to understand the potential transfer of information, skills, and resources between actors, most studies failed to describe the long-term impacts of various interventions or the actual transfer of these resources. Additionally, it is uncertain to what degree networks built during interventions were maintained when structural supports ended. Follow-up studies would provide insight into factors that may facilitate maintaining meaningful ties.

Most SNA studies use global networks, as they are considered more robust (Borgatti et al., 2018). However, studies of ego-networks (Perry et al., 2018) of rural teachers may help uncover some of the connections that compose teachers' networks for professional growth that may not be observed in an artificially bounded population. In a study of the ego-networks of teachers in four urban elementary schools, Coburn et al. (2012) found that all but one of the teachers had networks that expanded outside of the school boundary; a finding that would only have been seen in an ego-network approach. Researchers should consider the social networks of effective rural educators to determine if there are patterns in the types of organizations, people, or other resources they use to professionally develop in their practice. However, no prior studies were identified which utilized ego networks of rural teachers and administrators. Through a combination of global-level and ego-level networks studies of rural educators, researchers could better understand how to support these important and often overlooked educators.

References

*Allen, A. S., & Topolka-Jorissen, K. (2014). Using teacher learning walks to build capacity in a rural elementary school: Repurposing a supervisory tool. *Professional Development in Education*. https://doi.org/10.1080/19415257.2013.851104

Anttila, E., & Väänänen, A. (2013, March). Rural schoolteachers and the pressures of community life: Local and cosmopolitan coping strategies in mid-twentieth-century Finland. *History of Education*, *42*(2), 182–203. https://doi.org/10.1080/0046760x.2013.766267

*Aston, M., & Hyle, A. E. (Eds.). (1997). *Social networks, teacher beliefs, and educational change.* Annual Convention of the University Council of Educational Administration.

*Augustine-Shaw, D. (2016). Developing leadership capacity in new rural school district leaders: The Kansas Educational Leadership Institute. *The Rural Educator*, *37*(1). https://doi.org/10.35608/ruraled.v37i1.274

Aydin, N. (2018). Social network analysis: Literature review. *Online Academic Journal of Information Technology*, *9*(34), 73–80. https://doi.org/10.5824/1309-1581.2018.4.005.x

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. https://doi.org/10.1080/19415257.2010.494450

Baker-Doyle, K. J., & Yoon, S. A. (2020). The social side of teacher education: Implications of social network research for the design of professional development. *International Journal of Educational Research*, *101*, 101563. https://doi.org/10.1016/j.ijer.2020.101563

Berry, A. B., & Gravelle, M. (2013). The benefits and challenges of special education positions in rural settings: Listening to the teachers. *The Rural Educator, 34*(2). https://doi.org/10.35608/ruraled.v34i2.400

Biddle, C., & Azano, A. P. (2016). Constructing and reconstructing the "rural school problem": A century of rural education research. *Review of Research in Education*, *40*(1), 298–325. https://doi.org/10.3102/0091732X16667700

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2018). *Analyzing Social Networks*. SAGE Publications Limited.

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science*, *323*(5916), 892–895. https://doi.org/10.1126/science.1165821

Bristol, T. J., & Shirrell, M. (2019). Who is here to help me? The work-related social networks of staff of color in two mid-sized districts. *American Educational Research Journal*, *56*(3), 868–898. https://doi.org/10.3102/0002831218804806

*Broda, M., Ekholm, E., Schneider, B., & Hutton, A. P. (2018). Teachers' social networks, college-going practices, and the diffusion of a school-based reform initiative. *SAGE Open*, *8*(4), 215824401881739. https://doi.org/10.1177/2158244018817397

Burton, M., Brown, K, & Johnson, A. (2013). Storylines about rural teachers in the United States: A narrative analysis of the literature. *Journal of Research in Rural Education, 28(12)*, 1-18. Retrieved from http://jrre.psu.edu/articles/28-12.pdf

Carver-Thomas, D. & Darling-Hammond, L. (2017). *Teacher turnover: Why it matters and what we can do about it.* Learning Policy Institute. https://doi.org/10.54300/454.278

Cela, K. L., Sicilia, M., & Sánchez, S. A. (2015). Social network analysis in e-learning environments: A preliminary systematic review. *Educational Psychology Review*, *27*(1), 219–246. https://doi.org/10.1007/s10648-014-9276-0

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. https://doi.org/10.1086/667699

Coleman, J. S. (1988). Social capital in the creation of human capital. *American journal of sociology, 94,* S95-S120.

*Dailey, K. (2017). *A hermeneutic phenomenological exploration of the impact of technology on the collaborative practices of rural middle school teachers* [PhD Dissertation]. Liberty University.

Daly, A. J. (2010). *Social Network Theory and Educational Change*. Amsterdam University Press.

Daly, A. J. (2012). Data, dyads, and dynamics: Exploring data use and social networks in educational improvement. *Teachers College Record, 114*(11), 1–38. https://doi.org/10.1177/016146811211401103

Darling-Hammond, L., & Richardson, N. (2009). Teacher learning: What matters. *Educational leadership*, *66*(5), 46-53.

*Edwards, D. (2019). Cultivate, create, and connect: Virtual network builds community and sparks continuous improvement. *Learning Professional*, *40*(5), 56–60. https://eric.ed.gov/?id=EJ1235454

*Forfang, H. (2021). Relationships and interactions between school owners and school principals: A case study of a Norwegian school district programme. *Educational Management Administration & Leadership*. https://doi.org/10.1177/1741143220919766

*Garber, D. H. (1993). Staying in touch: The rural principals' network. *Rural Educator*, *14*(2), 13–15.

Goldhaber, D. (2016). In schools, teacher quality matters most: today's research reinforces Coleman's findings. *Education Next*, *16*(2), 56+. https://link-gale-com.byu.idm.oclc.org/apps/doc/A448138332/AONE?u=byuprovo&sid=bookmark-AONE&xid=a556883c

Grunspan, D. Z., Wiggins, B. L., & Goodreau, S. M. (2014). Understanding classrooms through social network analysis: A primer for social network analysis in education research. *CBE—Life Sciences Education*, *13*(2), 167-178. https://doi.org/10.1187/cbe.13-08-0162

*Hargreaves, A., Parsley, D., & Cox, E. D. (2015). Designing rural school improvement networks: Aspirations and actualities. *Peabody Journal of Education*, *90*(2), 306–321. https://doi.org/10.1080/0161956x.2015.1022391

*Hite, J. M., Reynolds, B., & Hite, S. J. (2010). Who ya gonna call? Networks of rural school administrators. *The Rural Educator*, *32*(1). https://doi.org/10.35608/ruraled.v32i1.434

*Howley, A., Chadwick, K., & Howley, C. (2002). Networking for the nuts and bolts: The ironies of professional development for rural principals. *Journal of Research in Rural Education*, *17*(3). https://files.eric.ed.gov/fulltext/ED463908.pdf

Jackson, C. K., & Bruegmann, E. (2009). Teaching students and teaching each other: The importance of peer learning for teachers. *American Economic Journal: Applied Economics*, *1*(4), 85-108. https://doiorg/10.1257/app.1.4.85

Kale, U., Brush, T., Bryant, A., & Saye, J. W. (2011). Online communication patterns of teachers. *The Journal of Interactive Learning Research*. https://www.learntechlib.org/p/33247/article_33247.pdf

*Karnopp, J. (2022a). Structures and relationships in organizational learning for change. *Journal of Educational Administration*, *60*(5), 457–472. https://doi.org/10.1108/JEA-09-2021-0177

*Karnopp, J. (2022b). Uncovering rural educators' secret agency. *The Rural Educator*, *43*(2), 34-46. https://doi.org/10.55533/2643-9662.1324

*Karnopp, J., & Bjorklund, P. (2022). Ties for the phases: Tie formation and educator life phases in urban fringe and rural schools. *Teachers and Teaching*, *28*(3), 315–329. https://doi.org/10.1080/13540602.2022.2062723

Kezar, A. (2014). Higher education change and social networks: A review of research. *The Journal of Higher Education*, *85*(1), 91–125. https://doi.org/10.1353/jhe.2014.0003

Li, Y., & Krasny, M. E. (2020). Development of professional networks among environmental educators. *Professional development in education*, *46*(2), 337-353. https://doi.org/10.1080/19415257.2018.1562957

Li, Y., & Krasny, M. E. (2021). Relationship between professional networks and practice change in environmental education. *The Journal of Environmental Education*, *52*(3), 174-189. https://doi.org/10.1080/00958964.2021.1899107

Lysberg, J. (2023). Unpacking capabilities for professional learning: teachers' reflections on processes of collaborative inquiry in situated teamwork. *Journal of Workplace Learning*, *35*(1), 1-16. https://doi.org/10.1108/JWL-01-2022-0008

Machalek, R., & Martin, M. C. (2015). Sociobiology and sociology: A new synthesis. *Elsevier EBooks*, 892–898. https://doi.org/10.1016/b978-0-08-097086-8.32010-4

Maher, D., & Prescott, A. (2017). Professional development for rural and remote teachers using video conferencing. *Asia-Pacific Journal of Teacher Education*, *45*(5), 520–538. https://doi.org/10.1080/1359866x.2017.1296930

*Mania, J., Pearce, D. M., Noonan, J., & Carpenter, K. (2022). A social network approach to diffusion of educational technology integration in the early childhood grades. *Chronicle of Rural Education, 1*(1), 1-19.

Manning, K. (2017). *Organizational theory in higher education*. Routledge. http://dx.doi.org/10.4324/9781315618357

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology, 27*(1), 415–444. https://doi.org/10.1146/annurev.soc.27.1.415

MetLife & Harris Interactive. (2013, April). *MetLife survey of the American teacher: Listening to teachers in rural schools*. The National Conference on Rural Education Research. Retrieved August 17, 2022, from https://files.eric.ed.gov/fulltext/ED542203.pdf

Monge, P. R., Rothman, L. W., Eisenberg, E. M., Miller, K. I., & Kirste, K. K. (1985). The dynamics of organizational proximity. *Management Science, 31*(9), 1129–1141. https://doi.org/10.1287/mnsc.31.9.1129

*Muijs, D. (2015). Collaboration and networking among rural schools: Can it work and when? Evidence from England. *Peabody Journal of Education*, *90*(2), 294–305. https://doi.org/10.1080/0161956x.2015.1022386

*National Association of State Directors of Special Education & Office of Special Education and Rehabilitative Services. (1990). *Maine's support network for rural special educators: Success through communication*. National Clearinghouse for Professions in Special Education.

Ouyang, F., & Scharber, C. (2017). The influences of an experienced instructor's discussion design and facilitation on an online learning community development: A social network analysis study. *Internet and Higher Education*, *35*, 34–47. https://doi.org/10.1016/j.iheduc.2017.07.002

Perry, B. L., Pescosolido, B. A., & Borgatti, S. P. (2018). *Egocentric Network Analysis: Foundations, Methods, and Models*. Cambridge University Press. (ISBN: 978-1-107-13143-9)

Queirós, A., Faria, D., & Almeida, F. (2017). Strengths and limitations of qualitative and quantitative Research Methods. *European Journal of Education Studies*. https://doi.org/10.46827/ejes.v0i0.1017

*Reading, C. E. (2010). Using ICT to increase professional connectedness for teachers in remote Australia. *Australian Educational Computing*, *25*(2), 3–6. https://eric.ed.gov/?id=EJ919327

Roberts, P., & Green, B. (2013, October 23). Researching rural places. *Qualitative Inquiry*, *19*(10), 765–774. https://doi.org/10.1177/1077800413503795

Sabina, L. L., Touchton, D., Shankar-Brown, R., & Sabina, K. L. (2023). Addressing teacher retention within the first three to five years of employment. *Athens Journal of Education*, *10*(2), 345-364.

Saqr, M., Fors, U., & Tedre, M. (2018). How the study of online collaborative learning can guide teachers and predict students' performance in a medical course. *BMC Medical Education*, *18*(1). https://doi.org/10.1186/s12909-018-1126-1

Schaeffer, K. (2021, December 14). *America's public school teachers are far less racially and ethnically diverse than their students*. Pew Research Center. https://www.pewresearch.org/fact-tank/2021/12/10/americas-public-school-teachers-are-far-less-racially-and-ethnically-diverse-than-their-students/

Spillane, J. P., Shirrell, M., & Sweet, T. K. N. (2017). The Elephant in the Schoolhouse. *Sociology of Education*, *90*(2), 149–171. https://doi.org/10.1177/0038040717696151

Trentham, L. L., & Schaer, B. B. (1985). Rural and urban teachers: Differences in attitudes and self-concepts. *Research in Rural Education*, 3(1), 3-5.

USDA ERS - Frontier and Remote Area Codes. (n.d.). https://www.ers.usda.gov/data-products/frontier-and-remote-area-codes/

*Wells, T., Chimka, M., & Kaur, S. (2021). Rural principal perspectives of leadership development needs. *The Rural Educator*, *42*(3), 45–55. https://doi.org/10.35608/ruraled.v42i3.1111

*Woodland, R. H., & Mazur, R. (2019). Examining capacity for "cross-pollination" in a rural school district: A social network analysis case study. *Educational Management Administration & Leadership*, *47*(5), 815–836. https://doi.org/10.1177/1741143217751077