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The potential of mixed-method social network analysis for studying interaction between agency and structure in education

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ABSTRACT

This article discusses the potential of mixed-method social network analysis (MMSNA) as a methodology for designing and conducting studies that address questions of interplay between human agency and social structures in educational settings. First, we discuss a rationale for using MMSNA referring to the theoretical calls for better understanding the role of agency in network structures. Next, we discuss examples of studies that illustrate how MMSNA has been applied to investigate (a) the role of agency in social network formation and (b) how social networks facilitate actors' agency in educational processes. Finally, we outline a guide for how to use MMSNA and consider its potential for future studies of interactions between agency and structures in educational settings.

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Introduction

The importance of individual and collective agency is increasingly emphasized in relation to the changing contexts of education such as technological developments, or increasingly diverse student populations that require collaboration between education professionals and other actors to address a range of student needs (Pantić *et al.* 2022, forthcoming). For example, school closures during the pandemic highlighted the role of agency in creatively responding to problems and collaborating in professional networks to shift to remote and hybrid modes of delivery, or tackle losses in learning and rising inequality (Ehren *et al.* 2021). Recent studies indicate that professional agency is largely socially embedded (Vähäsantanen *et al.* 2020) and dependent on resources actors are able to mobilize in their social networks (Pantić *et al.* 2021). Social network approaches examine connections (relational ties) among actors (nodes). Network data consists of structural variables, measuring the ties between a pair of actors and composition variables measuring actor attributes, such as gender, ethnicity (Wasserman and Faust 1994). Social network approaches have been suggested to offer promising ways of examining how agency evolves within social context of the learning environments (e.g. Baker-Doyle 2015). Following the calls for a more widespread application of MMSNA in the field of education (Froehlich *et al.* 2020b), in this article we discuss the potential of mixed-method social network analysis (MMSNA) that combines qualitative and quantitative

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approaches in the same study for understanding the interactions of agency and social network structures.

Social network analysis (SNA) has gained popularity in educational research over the last 30 years. However, despite the history of qualitative approaches in the earlier applications of SNA (see Freeman 2004 for a thorough analysis of the historical development of SNA), in the last three decades, social network studies have often taken a quantitative stance to identify network structures (Carrington *et al.* 2005, Crossley 2010, Edwards 2010b). Sweet (2016) provided a review of quantitative SNA methods and their potential for conducting analysis of individual attributes and network structures where the usual assumption of independence does not apply. For example, student outcomes cannot simply be seen as the effect of teachers' beliefs or competence, since they arise from complex interactions with many actors, including other students (Ryu 2020) as well as teachers, families, and other members of a school community (Lane and Sweeny 2019). In the field of education, researchers have recognized the distinctive value of SNA for analyzing complex and dynamic processes that involve an interplay of individual beliefs or behaviour and social structures (Hilpert and Marchand 2018). SNA has been used for addressing a range of important questions, such as whether individual actors in different social positions demonstrate different results on certain outcomes, and which individual attributes best predict the formation of particular relationships (Brouwer *et al.* 2018) or innovative work behaviour (Froehlich and Messmann 2017). However, quantitative analysis alone takes limited account of the role of actors' agency in forming or breaking social ties, that underlie some of the important questions in education settings (Froehlich *et al.* 2020b). In this article, we consider how qualitative and quantitative approaches have been integrated within studies that use social network analysis to unpack interactions between structure and agency. We draw on existing examples of MMSNA studies to consider the added value of this methodology in the field of education, and specifically its potential for advancing our understanding of the role of agency in social network structures and vice versa.

MMSNA combines quantitative and qualitative methods to generate insights into the individual actors embedded with the social structures. Structure and agency are seen as two sides of the same coin (Giddens 1984) although they can be separated for analytical purposes in empirical investigations (Archer 2000). Agency refers to a capacity of socially embedded actors to appropriate, reproduce, and, potentially, innovate upon the received culture in accordance with their individual and collective beliefs, understanding, or commitments (Emirbayer and Mische 1998). Agency in social networks is constituted by identities, dispositions, competence, resources, and knowledge that are generated through interactions and relationships within networks (Crossley 2010). We endorse the views of agency in education studies that focus on its relational and collaborative nature within social networks (Baker-Doyle 2015, Pantić *et al.* 2021), which are part of socio-cultural contexts that constitute agency and shape what actors see as possible within given environments (Eteläpelto *et al.* 2013). Social networks are both shaped by and shape agency, and agency can be seen as both a consequence and antecedent of networks (Moolenaar 2012). On the one hand, actors appropriate a network position bringing to bear their intentions, motivation, cognition, and sense-making of particular situations (e.g. Coburn 2001). Actors' motivations and intentionality are a critical part of human agency based on their beliefs that certain goals are worth pursuing (Bandura 2001). On the other hand, actors' intentionality is at least partly determined by their position in the network (Moolenaar *et al.* 2014), as well as the sense-making processes that shape their understanding of what is possible within given social, institutional, and cultural contexts (Giddens 1984, Emirbayer and Goodwin 1994, Archer 2000, Coburn *et al.* 2012). Qualitative and quantitative complement each other in studies that aim to illuminate this interaction by showing actors' perceptions and choices in relation to other actors they interact with. The quantitative data provides information on whether the ties exist while qualitative can help us understand why they exist.

We consider the applications of MMSNA in education drawing on the wider social scientific arguments for the use of MMSNA that come from the theoretical calls for better understanding the role of agency in social networks (Emirbayer and Goodwin 1994, Crossley 2010). Theoretically-driven calls

for mixing methods within SNA come from a dual interest in the structures or form of social relationships – often through an etic, or outsider view of the network – and the processes which generate these structures – emic, or insider perspectives of the network (Edwards 2010b). In this paper, MMSNA is considered as a means of investigating interactions between the macro-level network structures and human agency at a micro, actor-oriented level of individuals' thoughts, feelings, and actions. Such interactions between structures and actors' agency underlie many questions in educational research given that learning and teaching are both intra- and inter-personal, relational processes (Edwards 2010a, Hilpert and Marchand 2018). Our intention is not to provide a comprehensive review of studies that use MMSNA in educational settings (for review see Froehlich 2020). Instead, we aim to define and illustrate the salient features of MMSNA, providing both a theoretical rationale and a guide for how SNA methods can be mixed to examine how social structures are formed and elaborated through actors' agency and vice versa. Firstly, we introduce the background of MMSNA. Next, we outline a rationale for its use in educational research, drawing on examples of MMSNA studies to discuss its potential for illuminating the role of agency in the formation of relationships, which in turn make the social networks within which agency is exercised. Finally, we outline how researchers can use MMSNA for different purposes of mixing methods within social network analyses.

Background of MMSNA

MMSNA concerns 'any SNA study that draws from both qualitative and quantitative data or uses qualitative and quantitative methods of analysis and thoughtfully integrates the different research strands with each other' (Froehlich *et al.* 2020, p. 3; also see Domínguez and Hollstein 2014). Like other mixed-method approaches (Johnson and Onwuegbuzie 2004), MMSNA combines quantitative and qualitative methods in a single study addressing their respective weaknesses to bring about a more comprehensive understanding of the social network (Baker-Doyle 2015). Mixed methods research uses quantitative and qualitative approaches to collect and analyze data, integrate the findings, and draw inferences (Tashakkori and Creswell 2007). Here we outline the merits and limitations of quantitative and qualitative SNA methods, before discussing how they can complement each other in MMSNA approaches.

Quantitative studies collect numeric data and analyze it using statistical methods. Wasserman and Faust (1994) define a social network as a group of actors (nodes) who are connected through different relations (ties). A social network dataset consists of structural variables (i.e. information about the relations between individuals) and actor attribute variables (i.e. background characteristics of the individuals in the network). In educational settings, actors can be teachers, or students, or teachers and students, schools, universities, or other organizations. Examples of relations are information or advice seeking, friendship, or collaboration. Network properties can be measured at both the node level (egocentric analysis), sub-graph level (parts of a network, such a dyads or triads) and complete network level (sociocentric analysis) (cf. Froehlich *et al.* 2020a). For example, at node level, researchers are often interested in identifying actors who are most central in the network. A common measure of *centrality* is degree, or the number of ties that a given node has. Network-level measures capture features such as *density*, or the number of ties observed in the network as a proportion of all possible ties. Density is a descriptive measure of how well connected a network is, which can indicate how quickly information flows, or how well supported individuals are. Reciprocity is another important descriptive measure in SNA and is calculated as the proportion of observed ties that are reciprocated. The analysis can be conducted at different levels (e.g. individuals, groups, or organizations) with both descriptive and inferential analysis of the mutual effects of individual attributes and network structures. A fuller overview of network measures and types of social network statistical modelling is provided by Sweet (2016).

The merit of quantitative SNA is that it can provide an outsider view on the network structure and examine the effect of individual attributes on network formation (Jack 2010, Edwards 2010b), for

example using statistical inferential approaches, such as exponential random graph or stochastic block models (see Sweet 2016 for overview of SNA modelling). They uncover the patterns of relationships and help capture changes in networks, for example to test hypothesis about the impact of actors' positions or attributes. However, these structural models take limited account of actors' agency in how and why they are forming or breaking social ties within networks, which might be better understood from an insider perspective, with qualitative data (Baker-Doyle 2015). Social networks are more than a set of nodes and links between them that are commonly examined in quantitative studies (Crossley 2010, Sweet 2016). Individual attributes can also involve sets of beliefs, attitudes, motives, and other aspects of agency that inform individual actions and interactions with others. To disentangle social selection from social influence mechanisms, as part of the network dynamics, longitudinal sociocentric (whole) network data are quantitatively analysed with advanced social network analysis (the so-called stochastic actor-based models in RSiena; see Snijders *et al.* 2010; Steglich *et al.* 2010). However, quantitative analysis, for example using selection models, can only go so far in illuminating aspects of agency, for example in actors' choice of other actors they choose to interact with, but do not tell us much about why they make those choices for particular purposes or in particular contexts. Similarly, influence models might be used to examine the impact of network structures on individual outcomes, but a fuller understanding of how individuals perceive structures and how those perceptions shape their beliefs or behaviours, requires complementary qualitative data. Institutions and organizations can be characterized by norms and cultures that are both reproduced and changed to a different extent as a result of complex and dynamic, intentional interactions. The ties that matter for different educational questions involve power and conflict as well as collaboration and exchange of support and advice. For example, researchers have shown that teachers' social networks can both support and thwart innovation (Datnow 2012). Thus, it is important to understand the nature of relationships and content that are disseminated through the networks, as well as their structural properties (Baker-Doyle 2015). For example, where dense collaborative networks are found among teachers implementing a reform, we might want to understand the nature of norms that teachers are interacting around.

Qualitative SNA approaches take an insider view on the network by listening to inside voices (e.g. using narratives, ethnography, interviews) to examine the meaning of ties and the processes which generate network structure, as well as the context and culture of the network (Crossley 2010, Hollstein 2011, Crossley *et al.* 2015). Like other qualitative studies they typically collect textual data and analyze it using inductive thematic approaches (McCrudden and Marchand 2020). In SNA, qualitative approaches can offer different insights into the mechanisms of network formation. For example, interviews collect subjective data, on the actors' perception of how network dynamics may work; observations may collect data on unconscious mechanisms that may not be perceived by actors involved in networks. Qualitative data can also be collected about structures, for example ethnographic fieldwork might be used to understand organizational culture and norms. However, qualitative approaches on their own are limited in their ability to identify the blueprint of the network, that is, the patterns of social relationships (Crossley 2010), and in their potential for generating generalizable insights or hypothesis testing.

Within the general discussion about research data and methods, social network data and methods cannot easily be located on the continuum of qualitative to quantitative research methods, nor is it simply a combination of the two since the networks represent structures, rather than quantities (Hollstein and Straus 2006, Froehlich, 2022) although the properties of network structures such as its density or centrality can be quantified. Some authors in the domain of mixed methods research label SNA as an inherently mixed method (Froehlich and Brouwer 2021), but when studying the methods within social network research, some methods (and the data that they use) may be described as more qualitative-oriented relational methods and others as more quantitatively-oriented relational methods (Froehlich 2020). One of the most important features of MMSNA designs, where quantitative and qualitative data are integrated, is that it can capture the network structures as well as what 'flows' through them, by analyzing network properties in

conjunction with the content of exchanges (e.g. ideas or particular approaches and understandings) in order to understand the nature or quality of networks as well as their quantifiable properties. For example, Brouwer *et al.* (2020) used a quantitative SNA-approach to investigate the contributing factors of the development of communication networks in pre-service teachers. In this context, an MMSNA design could illuminate the information flow within the network structure rather than merely the contributing factors of the development of a communication network. Mixing quantitative and qualitative data within SNA can help us illuminate the role of agency in social network formation within the structures of educational institutions (Spillane *et al.* 2010, 2018, Baker-Doyle 2015). Considering that a social network is also a network of meanings, or as Emirbayer (1997) put it, 'agency is always agency toward something' (p. 294), MMSNA can be used to analyze both structural network properties and the content and nature of actor's agency, beliefs, motives or perceptions (Froehlich *et al.* 2020). In this paper, we consider the value of mixing quantitative and qualitative approaches within SNA for understanding both network structures and their underlying processes, and how they help unravel the dialectic between structures and agency in education studies.

Why use MMSNA in educational research?

MMSNA approaches have been employed in educational studies for understanding teaching and learning as complex, socio-culturally embedded processes, where educational outcomes result from social context as well as individual, cognitive processes (Hong and Francis 2020, Ryu 2020). Such studies, commonly rooted in Vygotsky's theory of learning as participation in social activity that organizes individual cognition (Vygotsky 1978), have enabled researchers to examine learning processes and outcomes that arise from networks of interactions that facilitate individuals' cognitive processes within particular social settings. For example, MMSNA studies of student engagement enabled researchers to uncover how students' individual and collective agency coevolved to explain the differences in individual performance relative to their social interactions, thus extending the understanding of engagement as something situated and embedded in interactions and relationships, rather than as an inert tendency or attitude (Ryu and Lombardi 2015, Ryu 2020). Mixed methods have also helped educational researchers to unpack complex phenomena, such as teacher identity (Hong and Francis 2020) where teachers' understanding of themselves as teachers is shaped by their interpretation of the contexts of their own experiences, their classrooms, schools, or communities, within which they engage with other social actors. MMSNA is particularly appropriate for understanding contextualized multi-layered phenomena that involve nested data and interactions between individuals within the classroom, school, or education systems (Hilpert and Marchand 2018). In multilevel mixed-method designs, quantitative data is typically collected at group and subgroup levels in parallel or sequentially with the qualitative data at individual level (McCrudden and Marchand 2020). MMSNA can help understand the dynamic processes that involve an interplay of human agency and social structures that shape and are shaped by both individual and collective behaviours and underlying beliefs, motives, or sense-making processes (Archer 2000, Hilpert and Marchand 2018, Jacobson *et al.* 2019).

Agency and structure in educational contexts

Influential theories of agency (Giddens 1984, Emirbayer and Mische 1998, Archer 2000) have been applied to study the work of teachers, including their interactions with others, such as students, colleagues, families, or other professionals (Moolenaar *et al.* 2012, Wubbels *et al.* 2012, Priestley *et al.* 2015, Pantić 2017). These day-to-day interactions can be seen as building blocks through which actors build more stable relational structures, which in turn enable or constrain their individual agency. Agency in education has been understood as a capacity to critically respond to problematic situations that is shaped by actors' underlying beliefs about their professional roles and embedded in multi-layered social contexts (Villegas and Lucas 2002, Biesta and Tedder 2007, Biesta *et al.* 2015,

Pantić 2015). Researchers used SNA to explore relationships within social structures in educational settings, for example to understand how teachers use their agency to form and maintain relations for particular gains (Moolenaar *et al.* 2014). However, quantitative analysis of network structures underpinned by rational choice theory – e.g. assuming that tie formation is driven by interest or gain, do not capture all the complex potential reasons why actors choose to interact e.g. in movements or other groups driven by particular ideas and norms (Emirbayer and Goodwin 1994). For teachers, professional communities that are characterized by shared norms and support that focus on student learning are shown to be beneficial for both student outcomes and innovative teaching practices (Vescio *et al.* 2008). In this context, MMSNA has helped understand the complex and subtle mechanisms in which actors exercise their agency to build such communities in the first place (see e.g. Baker-Doyle 2012 study below).

In what follows, we illustrate how different studies in the educational settings have benefitted from integrating quantitative and qualitative methods to examine the role of agency within SNA and generate findings that could not be obtained in individual-based analysis, or in structural approaches only. We will show how educational researchers applied MMSNA in studies of mutual influence of agency and structure, to understand two related kinds of processes. On the one hand, MMSNA has enabled researchers to get insight into the role of actors' agency in building social networks by studying the actors' underlying beliefs and intentions that determine the network structures. On the other hand, MMSNA helped explore the role of social networks as conduits for actors' agency and sense-making in change processes. We will also illustrate how MMSNA has been used to illuminate both processes in the same study viewing networks as both antecedents and consequences of agency.

The role of agency in social networks

A study that used a model of MMSNA reported in this journal (Baker-Doyle 2015) exemplifies how teachers exercise agency in social networks although the original study it refers to (Baker-Doyle 2012) did not explicitly focus on agency as an analytical concept. In her later paper, Baker-Doyle (2015) referred more explicitly to teacher agency to discuss how the MMSNA model enabled generation of insights on both the role of social contexts and individual relationships in the way novice teachers intentionally used and developed their support networks as a resource for professional support. The study (Baker-Doyle 2012) uncovered characteristics of first-year urban teachers' support networks. Surveys were used in which 24 teachers listed everyone that supported them in their teaching during the school year to map quantitative network characteristics such as network size (the number of actors in a network) and density (the proportion of actual ties between actors to potential ties). Four teachers, diverse in gender, ethnicity, and grade level, were studied more qualitatively and in-depth. The network properties of these four teachers were inspected closely, in addition to them being interviewed, observed multiple times, and involved in focus groups. Their narratives reflected different trends in their network characteristics and networking behaviour. The mixed-method approach enabled insight into how beginning teachers' beliefs and behaviours shaped their networks. By collecting and analyzing both quantitative and qualitative data, Baker-Doyle (2012) revealed, for example, that teachers who actively networked and collaborated with their school team members navigated the workplace better than other beginning teachers. These teachers also had a higher degree of 'relational knowing' – a term coined by Kagan (1992, p. 150) to describe awareness of how to negotiate social, political, and pedagogical dilemmas. MMSNA also helped understand how teachers' ability to connect to their colleagues was influenced by the school environment in different ways (e.g. the school's professional culture had an impact on how teachers ask one another for help), and how teachers' views of their professional selves and careers shaped their networking behaviours (e.g. a teacher who had a strong sense of professional identity connected to people supporting her in future goals and reinforcing her teacher identity).

Studies that explicitly focused on teacher agency in building social networks (e.g. Pantić *et al.* 2021) showed that teachers tend to reach out to other actors in diverse roles when they exercise a particular form of 'relational agency' to achieve goals that matter to them (Edwards 2010a). For example, when teachers are actively engaged in seeking support for students, their interactions with other actors involved more intense ties such as working together to solve a problem over time, rather than one of the exchanges of information or advice. However, qualitative data was essential for illuminating the nature of these interactions in studies where qualities of interactions in terms of their alignment to the principles of inclusive pedagogy was of interest as well as their presence or intensity (Pantić *et al.* 2021). Moolenaar *et al.* (2014) found that teachers who consciously shape their network by actively reaching out to others, have a more central network position and hence more access to the resources in the network. Here, agency is not viewed as an attribute or capacity that an individual possesses but as a function of resources afforded by social relationships (Lee 2014), illustrating the other side of the same process – how network structures shape agency.

The role of social networks as conduits of agency

In the educational context, MMSNA has been particularly suitable for examining change processes and how the underlying relationships shape individual and collective practices that facilitate or constrain reform efforts. Educational change is a socially constructed process in which actors identify and address problems to improve organizational performance (Argyris and Schön 1996). The underlying relationships within an organization influence this process by facilitating or constraining opportunities for knowledge sharing and innovation, which helps to meet the goals, such as reform implementation. For example, Penuel *et al.* (2009) employed MMSNA to investigate teachers' professional communities analyzing the role of formal and informal interactions in teachers' help networks, and to what extent they influenced change associated with school reforms. Two elementary school communities in California served as cases in this study. The study posited that valued resources and expertise are embedded within social networks and that it is through social connection that one has access and can mobilize resources to effect change. The MMSNA design was employed with an explanatory case study relying on data from a survey and interviews in two schools, as well as attribute data, such as participants' backgrounds. The interviews explored the values of expertise accessed through collegial ties, such as materials needed to implement the reform, time to collaborate for planning the implementation, access to experts inside and outside the school to assist with implementation. The interviews and attribute data from the surveys helped to understand and interpret the social structures, for example where densities were similar in the two schools, but the outcomes differed in terms of success in implementing the reforms. While the social network structures were captured via SNA, teachers' agency manifested in accessing valued instructional resources to support their efforts to enact curricular reforms. Interview data also helped reveal the differences in the school leaders' beliefs about the sources of expertise needed for school change underlying different approaches in responding to outside pressures and to the development of different school norms.

Daly *et al.* (2010) illustrate how the two kinds of purposes that relate to the use of agency in network building and the impact of networks on change processes can be combined in the same study. They applied MMSNA to explore how teachers exercise agency to implement, adapt or resist reforms depending on their socially embedded sense-making of the reform goals. They measured school social networks (around reading comprehension reform). More specifically, they measured network density of grade-level teams, rate of interaction with principals and coaches, percentages of reciprocal relationships, and how central each actor was, while interviews with a subsample of teachers from representative grade levels were used for exploring the reasons behind effects of teachers' social networks. Social networks significantly related to uptake, depth, and spread of reform, and MMSNA helped understand significant variance within and between schools in how the reform has been diffused and implemented. For example, while the principals

were central (in-degree ties) in all networks as the primary conduits through which the reform is initially diffused, MMSNA helped understand how the principals' strategies varied. Some principals were giving technical information from the district admin office while others encouraged collective learning by providing a frame of broader reform aims and leaving the implementation to teachers. Here MMSNA helped understand actors' agency by illuminating how they appropriated their network position bringing to bear their values and understanding of particular goals, which would have been difficult to capture with network metrics alone. Next, the study found that grade-level density and reciprocity varied both within and between schools, with more interactions within than between grade-level members, or with principals and coaches. Interview data also helped interpret the network structures by clarifying that more grade-level interactions were due to the fact the reading comprehension reform was regularly discussed in weekly grade meetings. MMSNA helped to explain that the differences between grade-level interactions (e.g. in density) related to the way teachers described their collaborative work in the interviews, with more interactions where the focus was on a common reading goal and instructional practice. Finally, the informal social linkages supported or constrained the depth of reform with a collaborative-learning orientation more present in dense connections, while sparse networks were more focused on technical aspects of reform. Here, interview data enabled a better understanding of the underlying motives because teachers did not want to maintain this technical focus – they expressed an unrealized desire to focus on more substantive issues but found themselves responding to administrative dictates (Daly *et al.* 2010).

Overall, MMSNA enabled understanding of the underlying agentic, sense-making processes to both identify and contextualize the findings of network properties that facilitate or constrain reform processes. At the same time, the study provided insight into teachers' perceptions of the affordances of their structural environments, which would not have been possible through the analysis of structural properties alone.

How to use MMSNA?

The question of how to mix methods in MMSNA relates to the consideration of the purpose(s). Schoonenboom *et al.* (2018) outline the following three purposes of MMSNA: (1) follow-ups (where, for instance, one strand of research aims to explain findings of a preceding strand of research or where replication of parts of a research strand is being aimed for); (2) comparisons (where one or more design feature, such as theoretical perspectives, methods, or researchers, are being triangulated); or (3) developments (where a preceding research strand aims to improve a subsequent research strand, for instance by allowing for a more purposeful sampling procedure or by improving the operationalization of a construct).

Researchers can make a few general decisions about the different components of MMSNA design to fit those purposes and integrate the different research strands. First, there is the *overall thrust or drive* (Schoonenboom and Johnson 2017), which focuses on the types of data and methods that are primarily being used in a study. The thrust can be qualitative – for example, where the focus is understanding the role of agency; quantitative – in research focused on the network structures, or both where agency and structures have 'equal-status' in a study, as the last example above has illustrated.

A second design decision is concerned with the *timing* of the strands of research. Two strands of research may be executed in sequence or simultaneously. This is not to be confused with the third criterion, dependence (Schoonenboom and Johnson 2017), which focuses on the information flows between the strands of research. If any data is being used to improve a component of another research strand, then this second research strand is dependent on the first.

A last but important design feature is about *integration*. Fetters *et al.* (2013) outline the specifics of how integration may be effectively implemented in a mixed methods research project. The overarching goal is to achieve a thoughtful and efficient link between the various strands of research used so that the whole becomes more than its parts. In other words: the potential of mixing can only be

realized if the multiple strands of research are integrated. This interface between the strands of research, or the point of integration of different strands of research (Schoonenboom and Johnson 2017), is about the stage of the research project where two or more strands are being combined. This may happen at any stage of the research, for example, when merging information from qualitative and quantitative data, when feeding information from one type of analysis into the next (e.g. Froehlich 2020), or when forming conclusions from separate analyses. A number of different, archetypical designs have been proposed in the literature about mixed methods research design, including, for example, explanatory sequential designs (where quantitative information is sequentially enriched with qualitative data to help explain the data), exploratory sequential designs (where the opposite route is being taken; exploratory qualitative findings are used to inform a more quantitative strand of research), or convergent designs (where multiple strands of research are conducted and parallel and their findings may be triangulated or otherwise combined at the end) (Fetters *et al.* 2013; Creswell 2014). Each design must be in alignment with the purpose of mixing that the researchers have specified for the design (Schoonenboom *et al.* 2018). Froehlich *et al.* (2020) have clarified that, in principle, the same archetypes are prevalent in mixed methods social network analysis, but that explanatory designs seem to be the most popular.

Cornelissen and colleagues (2014) illustrate how a variety of methods based on different methodological strands can be integrated through the sampling approach (a sequential aspect), but also during the discussion of the results (an aspect of parallel design) – such designs that do not fit a single archetype as presented above are sometimes referred to as fully integrated mixed methods research designs (Creamer 2017). This study focused on structural configurations of university-school partnerships and the ways knowledge generated from students' research is 'developed, shared, and used' in a reciprocal school-university network. In this analysis, MMSNA is used at both at the level of individual nodes and the whole sociocentric network. At the level of individual nodes, a purposeful sampling procedure was followed to identify four cases (two students and two research advisors). The selected cases were queried at multiple time points about their personal networks with logs and interviews. At the network level, data were collected via questionnaires (among all 19 students and the two selected advisors). In the egocentric approach all information about the alters is provided by ego (the focal actor) and with whom ego is connected, whereas in the sociocentric approach all actors in the network with a closed boundary (e.g. a school class) provide information about themselves and the connections among all actors are investigated (Borgatti *et al.* 2013). Although the research question is focused on a structural problem about network configurations between schools and universities, the study integrated structuralist and agency-focused ideas and data were collected and analyzed at the level of individuals and individuals' relationships with each other. This mixed-method design was useful for addressing the research question, as the phenomenon studied manifests itself at multiple units of analysis. The different methods used each had their own strengths and weaknesses in producing insight at any given unit of analysis. For instance, the qualitative methods made a limited contribution to the overall, structure-oriented research question, while they helped contextualize the research and make sense of the structure's impact on other units of analysis, such as the individuals acting within the structures. Other examples of how integration and mixing occur in MMSNA can be found in the review of Froehlich *et al.* (2020). Baker-Doyle (2015) also pointed out that MMSNA approach helped address the limitations of the purely quantitative or qualitative methods, by providing checks for data reliability on both sets of data.

Conclusion

MMSNA has the potential to help address research questions that strive for understanding of mutually formative influence of agency and social structures. We positioned MMSNA as a methodology that can help us understand the outsider (quantitative) perspective in concert with the insider (qualitative) perspective for a nuanced understanding of agency-structure phenomena in

educational contexts. The paper outlined the theoretical rationale that links agency and structures to the symbiotic uses of quantitative and qualitative SNA and illustrated how this methodology helped educational researchers generate insights that could not have been obtained in mono-method designs.

In particular, we illustrated applications of MMSNA for understanding agency in teachers' networking behaviour, for example, by seeking support to achieve their professional goals. In this context, quantitative SNA approaches could help understand relationships in networks, while complementary qualitative data can help us capture the content (ideas, values, purposes) that flow through the interactions within them.

Further, we illustrated how MMSNA has been used for explaining how social networks influenced agency in change processes, for example by uncovering the content and purposes of interactions through which reform was implemented or adapted in accordance with actors' influencing each other as they make sense of reform efforts. The outcomes depended on how agents themselves perceive the affordances of their structural environments. Here, MMSNA approaches provide crucial contextual details for the interpretation of such perceived structures.

MMSNA has also been useful in studies that combine the two kinds of purposes described above for understanding the social relationships through which access to resources is realized. While much attention has been given to quantitative SNA approaches wherein the network structure is investigated with the ultimate aim of revealing the degree to which interactions and subsequently an exchange of resources can take place, research examining the content of these resources or considering a combination of the structure and the content simultaneously have been scarce. Where MMSNA approaches have been used to investigate both structure and content, the studies have yielded a more complete understanding of the role of actors' agency, as the studies reviewed in this paper could illustrate.

MMSNA designs have commonly involved follow-up or developmental purposes of mixing, which have been useful for understanding network structures and their underlying beliefs at a given time or in relation to particular goals. In the future, studies could make more use of MMSNA's potential to uncover how relationships are reconfigured and reproduced over time. Longitudinal designs, including a simultaneous collection of quantitative and qualitative data, could be used to both explore and explain the mutually formative effects of human agency and social structures in educational research.

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