Historical, Theoretical, and Analytical Foundations

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Objectives

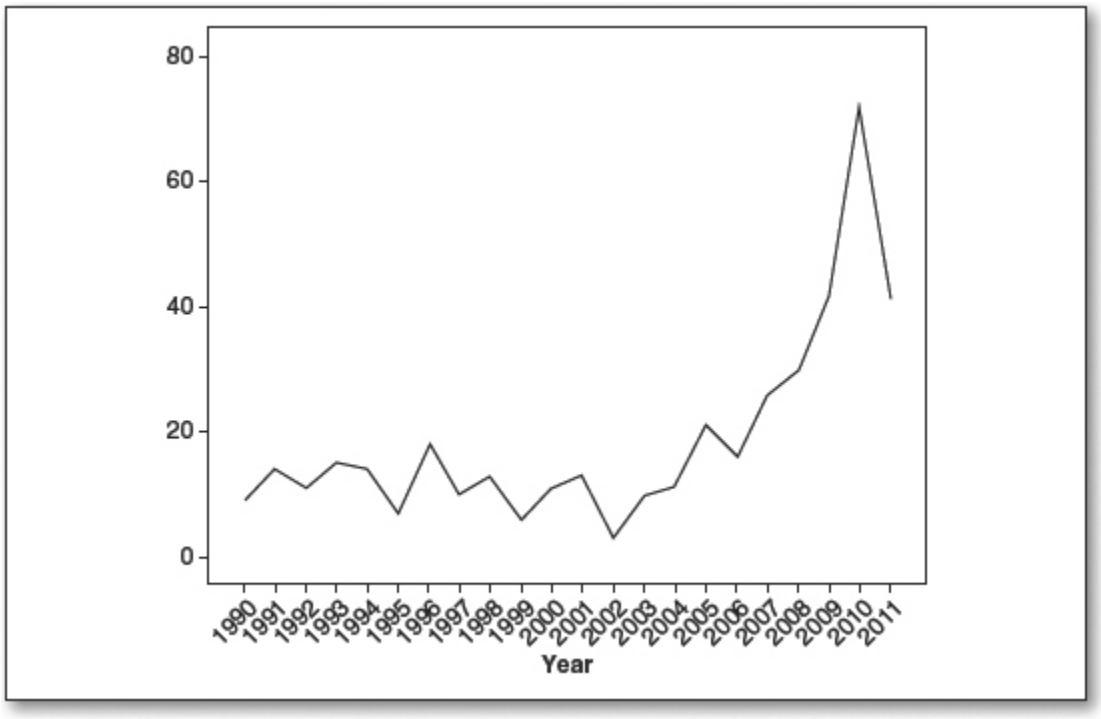
This chapter provides a concise summary of the interdisciplinary origins of social network analysis, with a special nod to sociology. In addition to introducing you to an array of applications across the social and natural sciences, this chapter will articulate how social network analysis is a both a theory and a method whose potential is great for advancing knowledge of numerous educational phenomena. Finally, despite the recent popularity of social network analysis, this chapter will demonstrate that many of its core tenets were established decades ago by those working within and, more importantly, across a number of disciplines.

Interest in Social Network Analysis

Public and scholarly interest in social network analysis has grown rapidly in the past 20 years, yet this interest still lags in educational research. The increasing number of applications of social network analysis across a wide range of phenomena has been documented by a number of studies, three of which are noteworthy. For example, Otte and Rousseau (2002) examined social network analytic articles published between 1984 and 1999, and from year to year they show that there has been an almost linear growth in the number of areas in which the social network approach has been applied. Borgatti and Foster (2003) also report near-exponential growth in the last two decades in publications within the social sciences that use the words *social network(s)* in the title, keywords, or abstract.

However, this growth has not only been across substantive areas, it has also occurred within the broad field of educational research. Moolenaar (2010) reports a similar near-exponential trend when expanding the search terms to include both *social network(s)* and *education*. This growth is easily confirmed with a quick scan of the ERIC database, one of the biggest and most widely used databases that catalogues an array of print content related to educational research. In 1990, there were only six pieces of content that contained the words *social network(s)* in their title or abstract; in 2011, there were 41. Of course, these search strict parameters underreport the amount of content in educational research that relates to social networks, but the point is just the same: interest and applications in the areas of social network analysis and educational research have grown, particularly in the last 5 years. Figure 2.1 shows this trend, chronicling its growth in educational research between the years 1990 and 2011.

Figure 2.1 Publications in ERIC, 1990–2011, with the Term "Social Network" in Either the Title or Abstract. In 1990 there were only six pieces of content that contained the words "social network(s)" in their title or abstract; in 2011 there were 41.



While this quick look at its use in educational research indicates that it has become more widely used—perhaps not as widely used as it is in other fields and disciplines—this does not, however, indicate that its applications have fully appreciated the richness of the social network perspective or the strengths of its analytical approach. In short, the study of social networks has become a euphemism for the study of any group process—for example, teachers collaborating on a curricular intervention, school leaders trying to build a consensus for reform, or parents working together to shape school policy. While topics such as these are ripe for social network analysis, several studies that have examined these topics have done so under the label of social network analysis while not leveraging its analytical power and continue to treat actors as mere collections of attributes.

Regardless, this seemingly exponential increase in social network analysis applications across substantive areas has contributed to its acceptance as a "normal" science, described by Kuhn (1962) as a deliberate approach that both identifies puzzles and solves them. Because a normal science is one that results from an ordered sequence of discoveries, it is also cumulative (Freeman, 2004). This cumulative growth is likely due in part to two distinguishing characteristics of the network perspective itself (Borgatti & Ofem, 2010). First, social network analysis is applicable to multiple levels of analysis. In educational research, this analytical lens can be applied to students, classrooms, schools, or districts. This makes it possible to study nearly any type of social system characterized by relations among actors. Second, social network analysis can combine the best aspects of qualitative, quantitative, and even graphical data, which allows for a richer description of

social life that is both contextually grounded and empirically rigorous.

This interest has resulted from nearly 100 years of interdisciplinary research—strongly but not exclusively influenced by sociology—that has sought to better understand the order beneath the messiness of social life. While social network analysis is becoming an increasingly interdisciplinary endeavor, it was largely developed within sociology and anthropology (Wasserman & Faust, 1994). This is not a coincidence, as social network analysis, sociology, and anthropology share the goal of explaining important social phenomena in terms of how particular units (such as people) are embedded in interconnected systems (McFarland, Diehl, & Rawlings, 2011).

Early Ideas and Practices

This growing interest in social network analysis is the byproduct of several different forces. As detailed by Freeman (2004), the evolution of social network analysis is a study of a social network in and of itself. Numerous others have reviewed the development of this perspective, both its theory and methods. However, it is worth noting the origins of social network analysis, as the story behind its development and evolution partially explains its current appeal and applicability.

While the intellectual underpinnings of social network analysis can be traced to sociological pioneers such as Comte, Durkheim, and Simmel, its modern applications can be traced to the work of Jacob Moreno in the 1930s. Both brilliant and quirky, Moreno himself is as responsible for the growth of social network analysis as he is for its eventual inability to influence the work of educational researchers.

As recounted by Freeman (2004), Moreno is credited coining the term *sociometry*, the graphical mapping of individuals' feelings about one another. In his most well known work, *Who Shall Survive?* (1934), he explicitly wrote about networks and the effects of two persons and the immediate group. This was demonstrated by showing that an epidemic of runaways at the Hudson School for Girls could be explained by the chains of social relations that connected all those who had left. The argument emanating from this insight was that the social relations among girls served as conduits though which ideas flowed. While the girls themselves may not have had an awareness of location in a social network, it was this very location that determined whether and when they ran away. This work established a defining tenet in social network analysis: Positions in social structure have consequences for the people occupying them.

This work, as well as subsequent collaborations with Jennings and Lazarsfeld published in his nascent journal, *Sociometry*, helped define the four distinguishing features of social network analysis. First, this work has strong structural intuitions—a focus on the embedded patterns of relations within and between groups. Second, it emphasized the systematic collection and analysis of empirical data. Third, this work included graphical imagery as part of its tools; and fourth, there was the use of explicit mathematical models, which helped induce the highest degree of objectivity possible. These are the same four features that continue to define the field (Freeman, 2004).

However, while growth of social network analysis owes much to his insights, he is also partly responsible for dissuading others from adopting and further developing this perspective (Freeman, 2004). By the middle of the 20th century, Moreno had become increasingly interested in therapeutic techniques, including group psychotherapy, psychodrama, and sociodrama, and moved further away from sociometric work. This shift drove early supporters away. In addition, he began to insist that what was then known as the sociometric paradigm had nothing to do with structural research but with strange links to God and psychotherapy. Researchers understandably began to question his entire body of work, and fewer and fewer people paid it any attention. The tentative links between sociology and sociometry faded completely shortly thereafter (Hare & Hare, 1996). So, while Moreno and his collaborators first developed the ideas and techniques of modern social network analysis, they were soon abandoned, and social research was left without a coherent structural approach that modeled actors and their relations in context.

Theoretical and Analytical Breakthroughs

However, these ideas were not entirely abandoned, as pockets of researchers across disciplines and institutions continued to develop the paradigm that ultimately became known as social network analysis. Others have provided a comprehensive history of these developments (e.g., see Freeman, 2004, 2011; Scott, 2000). However, it is worth noting that this history is punctuated by several sets of studies that provided the theoretical backbone to structuralism that ultimately evolved into social network analysis.

W. Lloyd Warner and his colleagues at Harvard produced the first set of influential studies in the late 1920s that focused on the study of social structure. Two of these studies are especially noteworthy. The first of these is what became known as the “bank wiring room study,” in which Warner and his colleague Elton Mayo explicitly focused on the formal and informal relations among workers at the Western Electric Corporation. Reported in detail by Roethlisberger and Dickson (1939), Warner and Mayo shifted the study from one that focused on the psychological study of individuals to one that stressed the patterning of informal ties among the workers. Data on interpersonal interactions were collected through systematic observation, with six different kinds of personal links measured, including who played games with whom, who traded jobs with whom, and who helped whom, among others. These data were then used to generate graphic images of the social ties among workers. Overall, this work was quite impressive and represented three of the core tenets of social network analysis, with the exception of sophisticated mathematical/computational tools.

The second line of research organized by Warner came to be known as the “Deep South” project, in which he and his team were concerned with the question and degree to which members of various social classes limited interaction to others at similar social class levels. Data were collected from 18 white women regarding which events they attended—an early example of a two-mode network—and were eventually analyzed to uncover who interacted with whom. The book that eventually emanated from his work, *Deep South* (Davis, Gardner, & Gardner, 1941), reflects the same emphasis on social structure that was present in all the work done by Warner's colleagues and students. Again, the only piece that was absent from this early work was

an emphasis on mathematical/computational tools.

Both of these influential studies and their emphasis on social structure led to other work at Harvard that continued to shape the work of subsequent researchers. For example, George Homans's *The Human Group* (1950) put both an empirical and theoretical focus on the “chains of interaction” that shape group processes and dynamics. Here, he specifically developed his threefold classification, proposing that frequency, sentiment, and joint activity are all interrelated and how groups emerge and recede is a result of this interrelation. A second influential work that followed was William Whyte's *Street Corner Society* (1943), a rich ethnographic account of the interaction patterns in a community that vividly uncovers a community's social structure. These two examples are in line with the structural emphasis initiated by Warner and others at Harvard. In addition, they helped clarify what sociologists conceptualized as social groups. Still, however, the mathematical/computational tools that would eventually become critical to social network analysis and provide more precision to this conceptualization did not inform this work.

As the structuralist perspective was still in its infancy despite the advances made by these pioneering works, the mathematical modeling of social structure was just gaining traction (Freeman, 2004). This body of research, first at MIT in the 1940s and then more productively at the University of Michigan thereafter, helped develop the mathematical tools that would ultimately be used to represent and test the theories generated by the emerging structuralist perspective. One of these mathematical tools that provided a foundation for social network methods was graph theory. Sociometricians at Michigan, notably Harary and Cartwright, used graph theory to represent social networks and a set of key concepts to study their formal properties. For example, building on Katz and Powell's (1955) work on reciprocity—that is, two actors nominating each other on a given tie—Cartwright and Harary shifted to a focus on groups of three actors (triads) and Heider's (1946) balance theory. This focus included their effort to quantify structural balance propositions and, along with Davis (1967), discussed which types of triads should and should not arise in empirical research (Wasserman & Faust, 1994). This work mathematically formalized Heider's concepts, particularly the core idea that if two actors are friends, then they should have a similar sentiment to a third—that triad is therefore structurally balanced. Around the same time, another big mathematical push to study social networks was occurring at Columbia University. Centered on the work of Paul Lazarfeld and Robert Merton, their work made use of network data designed to produce mathematical representations of social life, notably their work on communication friendship formation (1954).

The mathematical modeling of social structure advanced significantly with the use of algebraic operations to study multirelational networks. Many of these advances can be attributed to Harrison White and his colleagues and students at Harvard who leveraged his background as a theoretical physicist to study social structure and processes and to represent them through algebraic tools. Freeman (2004) describes how many of these students, in fact, later became leaders in social network analysis: Philip Bonacich, Barry Wellman, Marc Granovetter, Ronald Breiger, and others.

Several insights from these nascent efforts highlight their immense influence on contemporary social network analysis. Most noteworthy among these is the development of CONCOR (for CONvergence of iterated

CORrelations), which was an early computational attempt to partition actors into positions based on the concept of structural equivalence (this technique is demonstrated in Chapter 5). Structural equivalence, introduced and defined by Lorrain and White (1971), is a mathematical property of subsets of actors in a network. Two actors are structurally equivalent if they have identical ties to and from all other actors in the network. For example, actors A and B are structurally equivalent if both have ties to actor E and both have ties from actors C and D. That is, actors A and B occupy the same position. CONCOR, introduced by White's protégés Breiger, Boorman, and Arabie (1975), was an early effort to apply algebraic properties through computation in order to reveal a network's positions. While more flexible and efficient approaches have been developed in the years since, this approach was used extensively in network research in many fields (e.g., Friedkin, 1984; Knoke & Rogers, 1979). In addition, it should be noted that other programs (e.g., BLOCKER, STRUCTURE, and NEGOPY) that sought to identify actors occupying similar structural positions in a network were also developed around the same time.

While the development of CONCOR represented a major advance in network analysis, White and his colleagues also made further progress in the positional analysis of social networks. One of these advances included the pioneering use of blockmodels to represent network positional systems. Introduced by White, Boorman, and Breiger (1976), blockmodels consist of two components (Wasserman & Faust, 1994): (1) a partition of actors into positions and (2) for each pair of positions, a statement of whether a tie is present within or between positions on each relation. What was critical about this work was that it moved beyond simply identifying positions through structural equivalence and more toward theoretically meaningful statements about positions, the characteristics of actors in those positions, and, most critically, how those positions relate to each other.

Freeman (2004) correctly notes that the biggest contribution from White and his colleagues and students is that they directly confronted the reductionism of the positivists—the tendency to “reduce” individual actors to a collection of attributes removed from context—and the grand theories preferred by the natural and physical sciences. For example, when studying a topic such as teacher effectiveness, most researchers focus on the attributes of the teacher, the teacher's highest degree, use of technology, or test scores of students, for example. By reducing teachers to a set of attributes, positivists neglect the relations among teachers and between teachers and students and how these relations condition their effectiveness as a teacher. In paying attention to those relations, the advances by White and others provided the theoretical and methodological backbone to what was then recognized as structuralism. This view accounted for the web of relations—the social structure—in which actors are embedded that simultaneously constrain and provide opportunities for action. This work became intensely focused on an actor's environment, conceptualized as consisting of other actors and the relationships among them (e.g., collaboration among teachers and supervisory relations between principals and teachers). This focus became the distinguishing feature of what came to be known as social network analysis.

By the end of the 1970s, this theoretical and empirical work was so important that it became impossible for others, regardless of their field, to ignore the idea. This point is reflected in the increase in publications

across the social sciences that referenced “social network analysis.” This pioneering work was the clearest reflection of the four hallmarks of social network analysis: emphasis on structuralism based on ties among actors, firmly grounded in empirical data, made use of graphical imagery, and was mathematically based. It is not an understatement to conclude that as a result of this work, social network analysis came to be universally viewed as a legitimate set of tools among social scientists.

Computation and Large-Scale Networks

Following these advances in theory and modeling were a number of computational advances, without which Wolfe (1978) argues the field of social network analysis could not have developed further. These computational advances ultimately contributed to the analysis of large networks—those with literally thousands or even millions of social units, or even units that were not entirely social in the conventional sense (e.g., Web pages, phone numbers). While early computational tools were concerned with groups, positions, and other related structural properties, a number of other tools sought to provide an integrated suite of network analysis tools, including STRUCTURE, GRADAP, SONIS, and UCINET. The latter is by far the most popular and user friendly and, consequently, has made the biggest difference in the analysis of social networks, especially for those with modest training in mathematics.

While technologies have certainly made the analysis of networks easier and more efficient, there is still a lingering doubt among researchers and the public at large as to whether network analysis yields any novel theoretical insights or simply provides a “new” and flashy way to model the behaviors and attitudes of actors. This doubt has existed in one form or another since its advent.

Barriers to its Adoption in Educational Research

While disciplines and fields across the social sciences adopted and refined the structuralist perspective, its influence in educational research was minimal. While its influence on educational research has certainly grown in recent years, this growth is not at all proportional to the growth exhibited by proximate social scientific disciplines and fields. Why is social network analysis not used as often in educational research as it is used in these other areas?

There are three factors that have muted its influence over the years. The first among these is the dominance, at least in quantitative empirical work, of a psychological orientation to the study of educational processes and outcomes. With a narrow focus on constructs such as learning, psychology's disciplinary focus on individual explanations lent itself to experimental methods that stripped actors from context. For example, the research literature on motivation, especially drawn from the behaviorist tradition, is populated by studies that treat this construct as something that is rooted within the individual. While recognizing the importance of experimental designs that informed this work, this preference shunned the rich contextual description that was a hallmark of early social network analysis. More recently, the U.S. Department of Education's Institute for Education

Sciences went so far as to refer to these experimental designs, long preferred by psychology, as the “gold standard” of scientific research (Barnhouse-Walters, Lareau, & Ranis, 2009). It is difficult to dispute the strengths of these designs, particularly their ability to identify causal effects but these designs have limits when it comes to intentionally manipulating actual social networks under experimental conditions. How can you randomly assign actors to social groups and control for all relevant contextual factors that shape group dynamics? Such designs are perhaps possible but very challenging and maybe even undesirable to execute in the real world of research. It should be noted, however, that there are examples of social network analysis done through experimental designs (see e.g., Corten & Buskens, 2010; Kosfeld, 2004).

Related to this is the seemingly never-ending quest for educational researchers and their work to be considered legitimate. The best way to achieve this legitimacy has been to adopt the pretenses associated with science. For example, the logic of statistical inference and its associated analytical tools were widely employed in an effort to be on equal footing with peers in other social and physical sciences. When not employing experimental designs, generations of educational researchers were—and are still—trained to collect random samples drawn from target populations. These survey methods further removed the actor from context, asking questions about behaviors and attitudes that did not account for the behaviors and attitudes of those with whom they interacted. Because these survey methods relied on responses drawn from random samples, inferences to larger populations could be made. Researchers trained through schools of education adopted these techniques and solidified the importance of randomization and inferential statistics. A quick look at the quantitative research sequence that students take in just about any graduate program in educational research will most likely emphasize these two areas. Because of this, very few educational researchers were trained in linear algebra or matrix manipulation, the mathematics that are necessary to understand the logic of social network analysis. Educational research, at least the research that was most valued by its external constituencies, became a field populated by studies in which actors were removed from their social contexts. For example, rather than being concerned with who studied with whom and how these patterns conditioned one's motivation, educational research focused, rather, on issues such as predicting one's motivation from a set of individual attributes. These different foci are critical to understanding how this shift requires an entirely different way of thinking about educational research. This different way requires a shift in thinking of actors as independent entities, but rather actors who are dependent on others and shaped by context in which they are being examined.

The dominance of psychological explanations of education phenomena and the methods used to study these phenomena (experiments and population surveys drawn from random samples) were aided by the ascendance of popular computer statistical packages such as SAS and SPSS. Such packages allowed educational researchers to further shroud themselves as “scientists.” These packages, still widely used to train educational researchers, assist in the rapid calculation of population estimates from randomly—and not-so-randomly—selected samples of respondents. By relying on such packages, accuracy in predicting measures of students’ engagement, for example, became more important than understanding how one's location in a social structure influenced those levels of engagement. Regression became the tool of choice and is still the workhorse of most quantitative educational research. Complex models predicting whether there

was a significant relationship among variables could be run in a matter of seconds. Educational research became an industry that studied actors, students and teachers alike, using Likert scales that relied on self-reports of behaviors and attitudes. Seemingly all educational research done in this vein consisted of collecting measurements on variables from a random sample of respondents, with little to no thought given to the context in which these behaviors and attitudes emerge and recede. The software applications used to do this type of work reflected the permanence of this paradigm by arranging the data in a tabular format that treated actors (rows) as collections of attributes (columns); hence the term *actor-by-attribute* data.

While these trends were certainly influential in limiting the adoption of social network analysis in education, there was another sentiment that has percolated within and around the educational research community for some time. This sentiment revolves around questions regarding the quality and relevance of educational research (Barnhouse-Walters, Lareau, & Ranis, 2009). This, in part, explains the mad rush for legitimacy that spasms every so often among educational researchers and the institutions that prepare them. It also explains why a portion of the educational research community strongly clings to the experimental and random survey designs that constitute much of the work that has any real import outside of the educational research community. But it is not just concerns about its quality and relevance, it is the historical preference to employ qualitative designs that has limited the adoption of formal social network analytic techniques. There are a number of reasons why educational research has leaned toward these designs, but this preference has indeed hindered the adoption of social network analysis, which on some level provides a nice balance between the rigor of quantitative designs and the rich contextual descriptions inherent to qualitative designs.

In sum, the use of social network analysis in educational research was slowed by an overemphasis on individual explanations of educational opportunities and outcomes, a quest for scientific legitimacy, and a preference for experimental designs that estimate the causal effects of educational “interventions.”

The Integration of Theory and Method

Mische (2011) notes that one of the debates surrounding social network analysis has been whether it consists of a method or a theory. Is network analysis simply a set of techniques for analyzing the structure of social relationships, or does it make up some bigger conceptual framework, theoretical orientation, or even worldview? In an article over two decades ago synthesizing emerging work on social networks, Wellman (1988) argued that network analysis goes beyond methodology to inform a new theoretical paradigm: “structural analysis does not derive its power from the partial application of this concept or that measure. It is a comprehensive paradigmatic way of taking social structure seriously by studying directly how patterns of ties allocate resources in a social system” (p. 20).

From its earliest origins to it most recent applications to large-scale networks, social network analysis has reflected this interdependency between theory and method. This interdependency was made most evident in the advances made by White and his collaborators. It is a theory rooted in relational realism, one of the four main ontologies—explanations for how things come into being—identified by Tilly (2004). First among these

is phenomenological individualism, the doctrine that individual consciousness is the primary or exclusive site of social life. Second, methodological individualism is the doctrine that assumes human individuals are the basic unit of social reality but models them within consciousness (economic historians). Third, holism is the doctrine that social structures have their own self-sustaining logics. Fourth, relational realism is the doctrine that interactions and social ties constitute the central existence of social life. Tilly writes that relational realism is best equipped to overcoming the micro/macro gap in analysis because relationships simultaneously form organizational structures and shape individual behavior. It is this fourth one that most closely mirrors the intuitions that support social network analysis and most closely reflects its mid-range theories advanced by White and others.

Employed by Tilly to explain the emergence and resilience of patterned inequality, as well as an array of other social phenomena, relational realism (interchangeably referred to as *transactionalism*) offers you a lens through which the elemental unit of social life is the social relation—a repeated interaction between two or more actors. This confronts the methodological individualism inherent in most social science, emphasizing as it does the dispositions, motives, and calculations of individual social actors. Relational realism, as described by Tilly, also rejects the quest for governing laws to explain large social processes ranging from war, revolution, urbanization, and class formation to the formation of nation-states. Instead, Tilly advocated a careful analysis of social relations, empirical examination of the chains of connections linking persons through time and space in larger compounds of relations. Consider, then, how this approach would view a process such as “school reform.”

Relational Perspective

Mische (2011) goes on to note that a broader “relational perspective” within sociology and other social science disciplines has been simmering for the past three decades, often involving scholars who themselves do not use formal network methodology or who use it only marginally in their research. Inspired by such eminent figures as Harrison White and Tilly, this perspective has taken some of the broader theoretical insights of network analysis and extended them to the realms of history, politics, economics, and social psychology, each of them important disciplines that influence empirical research in education. Fundamental to this theoretical orientation (if it can be called that) is not merely the insistence that what sociologists call “structure” is intrinsically relational, but also, perhaps more deeply, that relational thinking is a way to overcome stale, false dichotomy between structure and agency through a focus on the dynamics of social interactions in different kinds of social settings.

This relational perspective is evident in a number of studies involving educational phenomena. A noteworthy example is McFarland's (2001) exemplary study on student resistance, which clearly represents the relational realism that Tilly employed in his myriad studies of social change. McFarland asks a question that many teachers likely ask themselves numerous times throughout the school day: Why do students defy me? Most explanations in response to this question, especially those offered by critical and resistance theorists, have focused on students’ race and class backgrounds (e.g., Ogbu, 1997; Willis, 1977). That is, these explanations

focus on attributes that one student may have in common with another and how collections of students who share these attributes are then socially disaffected. While not suggesting that these characteristics are unimportant, McFarland convincingly argues that this is only part of the story. Operating from a relational perspective, McFarland expands his lens to include the informal organization of the classroom, which determines which students have the greatest political opportunities, or rights to discourse, that enable them to use the available social opportunities that task structures define. Social relations and positions define who is most capable of taking advantage of social opportunities created by task structures. Friendship relations serve as networks of local support. Examining 36 classes in two schools over the course of 1 year, McFarland's analysis, which includes a number of student-level social network measures, reveals that students' background characteristics only partly influence students' decision to defy. Students' friendship networks play an important role; the main story is that classroom social networks and instructional formats explain a great deal more about everyday acts of defiance than do background characteristics alone. This example demonstrates that social network analysis represents a shift in the way in which social science, and most educational research for that matter, views how things (e.g., student defiance) come into being and how they work in certain contexts (e.g., classrooms). In addition, this work reflects the four tenets of social network analysis mentioned earlier.

Key Assumptions

Examples of studies that employ social network analysis are also predicated on three assumptions about patterned relations and their effects (Knoke & Yang, 2008). The first assumption is that social relations are often more important for understanding behaviors and attitudes than are such attributes related to one's background (e.g., age, gender, etc.). For example, in explaining differences in the success of a school-reform intervention, Atteberry and Bryk (2011) emphasize the importance of the density of social relations within a school and the position of key social actors prior to the implementation of the intervention. These structural relations—unlike "fixed" attributes such as gender, race, and age that do not vary in different contexts—exist only at a specific time–place and either disappear or recede when actors are elsewhere. For example, a relation between a literacy coach and a teacher does not exist outside a school setting; likewise, a professional relation between the first- and second-grade teachers does not exist outside that setting. A teacher who does not look forward to going to work and displays no enthusiasm for the job may be a dynamic head of household and committed member of a local governing body. Such behavioral differences are difficult to reconcile with unchanging attributes such as gender, race, and age. After all, these attributes do not change as the teacher moves from one role to the other in the course of her or his day. Actors' relations vary significantly across contexts. The structuralist perspective pioneered by White and refined by Tilly and the development of relational realism sharply contrasts with numerous reductionist approaches that are premised on individual "objects" as the unit of analysis. By positing, and with good reason, that patterns of relations condition social actors apart from their attributes, social network analysis offers a deeper and broader theoretical and empirical explanation for an array of educational opportunities and outcomes.

A second assumption inherent to social network analysis also reflects the integration of theory and method

that is a defining characteristic of social network analysis. This second assumption is that social networks affect beliefs, perceptions, and behaviors through a variety of structural mechanisms that are socially constructed by relations among actors (Knoke & Yang, 2008). This assumption motivates a wide array of studies in social networks. For example, social network analysts have focused on the importance of indirect relations brokered by intermediaries, which leads to valuable information for job seekers (Granovetter, 1973), or early access to diverse streams of information for competitive advantage (Burt, 2004). Relations that can be described as either competitive or cooperative influence mobilization efforts for collective action (Sampson, McAdam, MacIndoe, & Weffer, 2005) and maintaining shadow networks for terrorists (Moody, 2006) or drug traffickers (Natarajan, 2000). This assumption encourages social network researchers to uncover the theoretical mechanisms through which relations affect actors and to identify the conditions under which these mechanisms operate in specific contexts. In addition, it also places analytic importance on these relations.

The third assumption extends the idea that social network analysis is a perspective that integrates theory and method. This assumption is that relations are not static but rather occur as part of a dynamic process that is not adequately explained by conventional social theory, nor do the methods most often used by social scientists capture these dynamics. Relations are continually changing as actors interact with others in shifting contexts. In applying an understanding about networks to leverage advantages, actors such as teachers also intentionally or unintentionally transform the relational structures within which they are embedded. For example, Atteberry & Bryk (2010) show how the communication patterns between teachers and the their school's literacy coach affected the successful implementation of a school-level reform initiative. These relations, in turn, altered the flow of information among teachers and created further opportunities or constraints on future interactions and whether the intervention was ultimately a success. These dynamics, as Knoke and Yang (2008) note, reflect the more general micro-to-macro problem in the theory of social interaction (Coleman, 1986). Because social network analysis encompasses both social structure and individuals' agency, it provides the conceptual and methodological tools for linking behaviors at the actor level to larger embedded patterns at the macro level. This third assumption, then, is a direct offshoot of the relational realism advanced by Tilly.

Reconsidering the Qualitative/Quantitative Distinction

Social network analysis has evolved in a way that marries both theory and method, what Marin and Wellman (2011) refer to as the "social network perspective." But, while it includes elements of both qualitative and quantitative designs, as evidenced by McFarland's (2001) ethnography, questions linger as to whether it is more closely aligned with one than the other. Unfortunately, this divide still polarizes the field of educational research and shapes students' preparatory experiences as they become researchers themselves. It is indisputable that contemporary social network analysis relies extensively on linear algebra and matrix manipulation. After all, one of its distinguishing features is the use of mathematical models to objectively reflect social life. But this does not necessarily mean that it is exclusively quantitative in nature. So what is it?

Subsequent chapters introduce the quantitative techniques that examine the statistical relationships among network and attribute data. While this is an inescapable feature of most contemporary social network analysis, it is critical to recall that actors—students, teachers, schools, and so on—are concrete and observable, or groups of observable actors, such as those occupying the same position or social group. The relations that are of interest from the perspective of social network analysis are usually in the first instance social, cohering together or differentiating concrete entities, rather than simple statistical units (Breiger, 2004). Social network theorists and analysts go as far as to recognize that the inductive modeling strategies of social network analyses—that is, generating big ideas from small observations—are in opposition to the usual canonical assumptions of statistical methods, which prefer a deductive logic that operates from ideas to observations (Levine, 1999).

Undoubtedly, a great deal of progress has been made in the statistical analysis of social networks, including a number of important contributions to the general linear model that take into account the nonindependence among observations and the presence of clear patterns of dependence. These inferential models are introduced in Chapter 8. Nonetheless, social network analysis is difficult to categorize as an empirical strategy that is more quantitative than qualitative. This suggests that it is highly distinctive research perspective that cuts across a number of disciplinary boundaries and traditions (Breiger, 2004).

Because progress has been made in the statistical and substantive analysis of social networks, this has further blurred the line between qualitative and quantitative approaches to data analysis. Typically, social network analysis is a case study, bounded by both time and space. Important contributions to data analysis have combined rich ethnographic work and field observation with application of network algorithms. McFarland's (2001) earlier-referenced work is a great example of this. Therefore, contemporary social network analysis muddles the traditional divide between qualitative and quantitative strategies and includes a mix of strategies, including statistical, algebraic, discursive, and cultural. These diverse strategies require social network analysts to expand their range of theoretical and analytical tools to compensate for the ways in which traditional graduate preparatory experiences fall short.

Educational Applications

Social network analysis provides a powerful alternative methodology for studying educational phenomena, but until recently, its ability to fulfill this goal has been severely limited by a number of factors, including computational and statistical power, and the mismatch between classical theory's description of social reality and the ways in which this reality has been empirically studied (McFarland, Diehl, & Rawlings, 2011). What follows is a small sample of areas relevant to educational researchers that have benefitted from the theoretical and methodological advances made by social network analysis. The relational perspective that has matured in concert with the methodological techniques associated with social network analysis has driven these advances.

Social Capital

One area that reflects this relational perspective and has provided much fodder for research in a number of different contexts is social capital. While this theory has been developed and tested in a wide range of contexts, a number of theoretical insights have been derived from work in educational settings. For example, a common assertion in education reform is that you need to create school environments with stronger community in which people are "better connected." This connectedness is viewed as an asset that improves performance by facilitating coordination, trust, and the spread of information—a notion often referred to as social capital (Bourdieu & Wacquant, 1992; Coleman, 1990; Putnam, 2000). Unfortunately, the rhetoric and research pertaining to social capital in schools can easily fall near one of two ends of a spectrum.

On one hand, education reformers are apt to discuss connectedness or social capital in metaphorical terms that, although rooted in the wisdom of clinical experience, often leave underspecified the mechanisms through which social structure impacts student performance. On the other hand, researchers trying to measure the impact of social capital in schools often reduce social relations to a set of variables that capture the properties emerging from interpersonal interactions within a social structure but do not necessarily capture the features of that social structure itself. Consequently, though such studies are very valuable in revealing the association between properties such as perceptions of trust, collegiality, adherence to norms, availability of information and support, and educational outcomes of interest. They usually stop short of attempting to unravel the relational mechanisms responsible for the associations.

However, by providing a way to frame, map, and quantify the relations between people, the social network perspective helps bridge the gap between the mechanisms implicit in reformers' arguments and the empirical rigor required by researchers to draw valid inferences. Through the social network perspective, two different mechanisms have been identified as generating social capital. First is the social closure hypothesis, first identified by Coleman to explain differences in academic achievement between Catholic and public schools. Second is the structural holes hypothesis (Burt, 2004), which contends that those actors occupying bridging roles between distinct groups possess a number of advantages, including early access to information and control over how information flows between distinct parts of the network.

Regardless of the mechanism that you believe is more responsible for the accrual of social capital, the larger point is that this theory is a byproduct of the relational perspective that has emerged over the past three decades of social scientific research. It also provides a much-needed theoretical lens through which empirical reality can be more properly evaluated. This relational perspective has also propelled theoretical developments in other areas that are relevant to educational researchers.

Diffusion

A second area in which educational research has generated theoretical insights through social network analysis is the area of diffusion, particularly how innovations spread through and across organizations such

as schools. It is also evident that relational realism has influenced the content and direction of studies within this broad topical area. While the study of diffusion processes—that is, how ideas, attitudes, and behaviors spread from one actor to another—has a long, impressive history (see e.g., Valente, 2005), recent work in and around schools by a number of researchers has contributed to this body of knowledge.

Three studies are noteworthy, all of which focus on the importance of one's network position in shaping diffusion processes and outcomes. First, Frank, Zhao, and Borman (2004) study the way in which the adoption of computer technology in six schools was influenced by one's access to expertise through talk and help. Another example is Coburn, Choi, and Mata's (2010) ethnography that reveals the organizational features of schools that either encourage or inhibit the flow of information across teachers. A third example that focuses on diffusion in schools is Penuel, Frank, and Krause's (2010) study on the critical roles of informal and formal school leaders in advancing reform goals.

Peer Influence

A third area in which social network analysis has contributed to insights that have significant implications for educational researchers is in the modeling of peer influence (also referred to as social influence). There is an expansive literature on social networks and peer influence (e.g., Friedkin, 1998; Friedkin & Johnsen, 2011), which has informed studies ranging from the formation of teachers' attitudes toward reforms (Cole & Weinbaum, 2010) to how the characteristics of friends shape high school students' aspirations and college attendance (Hallinan & Williams, 1990). Building from normative and comparative reference group theory and role theory, this strand of network-based research has sought to explicate the specific mechanisms through which individuals become vulnerable to influence or are able to exert influence on others. Moreover, it has focused on the conditions under which these processes play out. This area of research has much to offer, particularly in regard to how individual student outcomes are shaped by a variety of influences related to the smaller groups with which they are affiliated. For example, the interactions and shared experiences of two students who are assigned to the same academic track increases the likelihood that they will become friends. Since stronger friendships imply greater vulnerability to influence, students are likely influenced more by friends who are in the same track than by those in different tracks (Hallinan & Sorenson, 1985). Such social influences have obvious consequences for individual student outcomes.

These three research areas represent a small sample of the possible areas in which you can use the social network perspective to further advance ideas that cut across the social sciences and be applied to social phenomena in and around schools. However, more broadly speaking, social network analysis can also propel the entire field of educational research in a more productive direction that will ultimately add insights not only to these three areas but also to a number of other areas that are relevant to educational researchers, including trust, culture, and authority.

How can Social Network Analysis Further Advance Educational

Research?

There are three potential ways in which social network analysis can advance educational research (for an earlier treatment on this topic, see Frank, 1998). But it can also help the field move past the qualitative/quantitative divide and the methodological individualism and its empirical assumptions of normality and independence that are at odds with classical social scientific theory's description of social life (McFarland, Deihl, & Rawlings, 2011). Undoubtedly, social network analysis will continue to make advances in the areas of social capital and diffusion, especially as they pertain to educational contexts. But there are three broader ways in which social network analysis can further advance the quality, range, and relevance of social science research in general and, more specifically, educational research.

The first potential contribution of social network analysis is its ability to close the gap between sociological theory and empirical reality (McFarland, Deihl, & Rawlings, 2011). As noted earlier, there has always existed a divide between the discipline's theoretically informed vision about the nature of social process and the ability to capture them empirically. For example, some have pointed out that techniques such as general linear modeling distort social scientists' view of the world (Abbott, 1988), and there is a long history of researchers cautioning that many of the basic assumptions of common methods, such as independence and normality, are contrary to classical theory's description of social reality (Emirbayer, 1997; Martin, 2003). Methods such as hierarchical linear modeling (Bryk & Raudenbush, 1992) were originally designed precisely to help close this gap between theory and empirical reality. By allowing variance to be measured at multiple levels, hierarchical linear modeling presents a method more in line with our understanding of the nested relationships of students, classrooms, and schools. By challenging firmly established paradigms and procedures and providing an opportunity to model educational phenomena in ways that better represent the intersection between theory and empirical reality, social network analysis represents another viable alternative to studying social phenomena in and around schools.

In addition to closing the gap between theory and empirical reality, social network analysis can further advance educational research, as there have been numerous statistical breakthroughs and substantial increases in computing power that have allowed for the development of progressively more sophisticated techniques (McFarland, Deihl, & Rawlings, 2011). For example, social network analysis and its related models can now handle millions of actors, and new methods for dynamic and temporal features of networks continue to be at the forefront of the field (e.g., Boyack, Börner, & Klavens, 2009). Much of what social network analysis offers educational researchers, then, is a better means for capturing these complex interdependencies and fluid dynamics than many current and more popular methods are able to.

Finally, social network analysis has the capability to help refine the field's varied theoretical lenses in questions in light of social change (McFarland, Deihl, & Rawlings, 2011). As statistical tools become more sophisticated and their explanatory power more obvious, they come to be applied to an increasing number of topics. This, in turn, brings about new questions, again often requiring the development of even more

advanced tools in order to find answers. It is through these iterations that social network analysis helps educational researchers refine and reconceptualize the very understanding of the social phenomena in which they are interested. You can see this happening within education as many emerging lines of research focus on network aspects of educational and schooling processes. For example, social network analysis and its underpinnings in relational realism have helped reframe teaching and learning by focusing attention on the role of trust (Bryk & Schneider, 2002), relations among teachers (Coburn & Russell, 2008), and the relationship between social capital and student outcomes (Carolan, 2010). For each of these three reasons—the ability to close the gap between theory and empirical reality, the capacity to deal with complex new forms and amounts of data, and the capability to help refine one's theoretical lenses in questions in light of social change—social network analysis is poised to become an increasingly central set of tools on which educational researchers can draw and, in turn, bring about a paradigm shift from methodological individualism to relational realism.

Ethics and Social Network Analysis

This shift, however, will likely continue to test the ethical boundaries that strictly guide educational research. These ethical issues are both straightforward and complex (Kadushin, 2005). In standard-practice social science research, anonymity or confidentiality are both routinely granted to respondents, informants, and participants in experiments and observations. However, this is problematic in social network analysis in which the respondent not only has to identify him- or herself but also those with whom he or she has ties. Therefore, in conducting social network analysis, it is crucial to do no harm to the participants by (1) emphasizing the voluntary nature of the data collection; (2) disclosing how the data will be used; and (3) disguising the data to maintain confidentiality (Daly, 2010). As the field is relatively new and often misunderstood by members of institutional review boards, further ethical concerns will surface and need to be addressed.

Summary

This chapter provided a brief review of the historical and theoretical foundations of social network analysis. These foundations cut across a number of social scientific disciplines but are firmly grounded in sociology and its emphasis on the importance of relations among actors' bounded social structures (hence the early reference to "structuralists"). The maturation of social network analysis as both theory and method has resulted in a begrudging acceptance that most social science research, especially in a diverse field such as education, needs to conceptually and analytically account for the nonindependence of observations.

Critical Questions to Ask about the Historical, Theoretical, and Analytical Foundations of Social Network Analysis

Before conducting your own social network study, ask whether social relations are critically important for understanding the outcomes in which you are interested. Also, evaluate whether social networks affect beliefs, perceptions, and behaviors through a variety of structural mechanisms that are social constructed by relations among actors. Finally, how will your study exhibit an integration of theory and method?

What is the relational perspective and how does it offer a different perspective for educational researchers?

How does social network analysis challenge educational researchers who view themselves as more quantitatively or qualitatively oriented?

Chapter Follow-Up

Search the ERIC database for a peer-reviewed article that has the words *social network(s)* in its title or abstract. Using this article, explain how and to what degree the study reflects the four hallmarks of social network analysis: emphasis on structuralism based on ties among actors, firmly grounded in empirical data, use of graphical imagery, and mathematically based.

Using the same article from the question above, describe the study's ability to straddle qualitative and quantitative paradigms.

Finally, evaluate how the use of the social network analysis in this same article bridges the gap between sociological theory and empirical reality.

Essential Reading

Borgatti, S. P.Molina, J. L. Toward ethical guidelines for network research in organizations. *Social Networks,*(2005).27(2),107–117.

McFarland, D. A. Student resistance: How the formal and informal organization of classrooms facilitate everyday forms of student defiance. *American Journal of Sociology,*(2001).107(3),612–678.

Tilly, C. Observations of social processes and their formal representations. *Sociological Theory,*(2004).22,595–602.

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