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The Social Network Perspective and Educational Research Introduction

"We are surrounded by concentric circles of special interests… However, a person is never merely a collective being, just as he is never merely an individual being."

Georg Simmel (1908/1950, p. 261)

OBJECTIVES

The primary objective of this chapter is to establish a central point in social network analysis: relationships shape a person's behavior and/or attitudes beyond the influence of his or her own individual characteristics. This orienting chapter establishes this point by demonstrating how this theoretical and methodological approach differs from conventional approaches used in educational research, which often views individuals as mere collections of attributes. Upon completion of this chapter, you will be able to (1) distinguish how social network analysis differs from other conventional approaches and (2) weigh its value and utility in the context of contemporary educational research.

THE SOCIAL NETWORK PERSPECTIVE

It is undisputed that a person's sex, age, and socio-economic status, among factors, are critical determinants of one's educational opportunities and outcomes. In fact, the consensus is that these individual-level attributes are responsible for 70 to 90% of the variation in relevant educational outcomes, such as subject-area achievement, graduation, and grade promotion (Bryk & Raudenbush, 1992). Less appreciated, and often unaccounted for, are the roles that one's relationships with others play in shaping these opportunities and outcomes. While most would agree that relationships do matter, most methods and models used in educational research do not properly account for these influences. This absence is odd given that relationships influence a person's behavior above and beyond the influence of one's individual characteristics (Valente, 2010). After all, characteristics such as one's academic history or educational aspirations influence who one knows and spends time with. That is, these characteristics both shape and are shaped by individuals' social networks. Recognizing that these individual attributes are important, social network analysis focuses on the types of relations one has with others and how these relations influence individual and group behavior and/or attitudes.

A social network is a group of individuals and the relation or relations defined on them (Wasserman & Faust, 1994). The analysis of social networks is distinct, however, from the other individual-based approaches that dominate educational research or any other research within the social and behavioral sciences. What makes it distinct is that, in addition to focusing on the individual, the relationships that connect that individual to another are of central importance. Social network analysis, therefore, is not simply an analytical method but a set of theories, models, and applications that are expressed in terms of relational concepts and processes. Relationships defined by connections among individual units—students, teachers, or school districts—are a fundamental aspect of social network analysis. While interest in social network analysis has grown in both the natural and social sciences, a set of agreed-upon principles has emerged that distinguishes this approach from others. Wasserman and Faust (1994) note that, in addition to the use of relational concepts, social network analysis emphasizes (1) individuals and their actions are viewed as interdependent; (2) relational ties between individuals are opportunities for transmission of resources; (3) the pattern of relations among individuals—the social structure—is an environment that can either provide opportunities for or constraints on individual action; and (4) social network models conceptualize structure as enduring patterns of relations among actors.

FOUNDATIONAL CONCEPTS

The social network perspective—that is, its theories, models, and applications—consists of several concepts that are fundamental to an introductory discussion of social networks.

Actor

At the core of social network analysis are the connections among social units and the outcomes associated with these connections. These social units are typically referred to as actors: discrete individual or collective social units. Examples of actors in educational research are students in a classroom, departments within a school, teachers in a district, or parents in a community. The use of the term *actor*, however, does not mean that these units have the ability to "act." Rather, the use of the term *actor* connotes a social unit that is playing a role in a larger social system.

Typically, the social network perspective focuses on collections of these actors that are of all the same type. An example of this would be a set of teachers adapting to a mandated whole-school reform initiative. Collections of actors in this manner are referred to as one-mode networks. However, other methods also allow you to focus on actors that are conceptually different. These two-mode networks consist of two different sets of actors, for example, the relationship between a set of students and the courses they take (Field, et al., 2006). In this example, there are two sets of actors: students and courses. The latter, of course, is an example of a social unit that does not have the ability to "act."

Ties

Ties connect actors to one another. The range of ties connecting any two actors can be extensive. Some of the more common ties used to denote connections among actors in educational research include:

- Behavioral interaction (e.g., talking to each other or sending messages)
- Physical connection (e.g., sitting together at lunch, living in the same neighborhood)
- Association or affiliation (e.g., taking the same courses, belonging to the same peer group)
- Evaluation of one person by another (e.g., considering someone a friend or enemy)
- Formal relations (e.g., knowing who has authority over whom)
- Moving between places or status (e.g., school choice preferences, dating patterns among adolescents)

The ties on which you focus are driven by theoretical and/or empirical interest. But defining what constitutes a tie is a thorny methodological issue discussed in Chapter 3.

Groups

At the most fundamental level, a connection between actors establishes a tie between two actors. A tie between two actors forms a dyad, the basic unit for analysis of social networks. Therefore, dyads are pairs of actors, whereas triads are triples of actors. It follows that a subgroup can be defined as any subset of actors and all the ties among them. Locating and studying these subgroups, whether dyads, triads, or some larger subgroup, has been an important concern in social network analysis and is discussed in more depth in Chapter 5.

However, not all social network analysis is concerned with dyads, triads, or subgroups. For many, the attraction of social network analysis is its ability to model the relationships among systems of actors. A system consists of ties among actors in a bounded group. The concept of group, however, has been treated numerous ways among social scientists. For the purposes of this book, a group is defined as the collection of actors on which ties are to be measured. Following Wasserman and Faust's (1994, p. 19) definition, a group "consists of a finite set of actors who for conceptual, theoretical, or empirical reasons are treated as a finite set of individuals on which network measurements are made."

The limitation to a finite set (or sets) of actors is a simple analytic requirement. Though advances in computing have made it possible to examine ties extending among actors in a seemingly infinite group of actors, analyzing the data in any meaningful way would be problematic. Modeling finite groups is challenging enough, including the identification of network boundaries, sampling, and delineating group membership. These are topics addressed at length in Chapter 4.

Relation

It is unadvisable for you to collect information on just one social tie. Rather, information is collected on multiple ties in an effort to capture the richness of the connections, or lack thereof, among actors. Therefore, you typically measure multiple relations, defined as the collection of ties of a certain kind among actors in a group. For any group of actors, you might measure several different relations. For example, in addition to measuring friendship among adolescents, you might also record the friendships among parents of this same set of adolescents and the curricular choices they make. The important distinction here is that a relation refers to a collection of ties of a specific kind measured on pairs of actors from a specific set of actors. Ties themselves only exist between pairs of actors.

Social Network

Each of the preceding foundational concepts is essential to understanding the social network perspective. Having defined a social network as a finite set (or sets) of

actors and the relations or relations defined on them, we can now think of a social network as consisting of three essential elements: (1) a set of actors; (2) each actor has a set of individual attributes; and (3) a set of ties that defines at least one relation among actors. Putting it all together, the social network perspective is one concerned with the structure of relations and the implication this structure has on individual or group behavior and attitudes.

Compared to other research paradigms and their associated methodologies, social network analysis has several distinctive features. These features not only distinguish it from the typical approach that removes the individual actor from his or her context, but they also speak directly to the reasons why the social network perspective provides an exceptional suite of tools to fully explain a wide range of processes and outcomes that are of interest to educational researchers. Together, these features define the social network perspective (Freeman, 2004)

- Social network analysis is motivated by a relational intuition based on ties connecting social actors.
- It is firmly grounded in systematic empirical data.
- It makes use of graphic imagery to represent actors and their relations with one another.
- It relies on the use of mathematical and/or computational models to succinctly represent the complexity of social life.

The historical development of these contemporary features is discussed at the beginning of Chapter 2, which sketches the transdisciplinary history of social network analysis. These four features are applicable to a wide range of social and behavioral phenomena. Because of its wide applicability, the social network perspective can be used to understand phenomena that have historically been of interest to educational researchers.

APPLICATIONS TO EDUCATIONAL RESEARCH

The utility of the social network perspective is best described through an example that employs the foundational concepts just introduced while also previewing some other concepts that will be introduced throughout the text. Throughout this book, many new terms will be used, and a list of key terms is available on the book's companion website available at http://www.sagepub.com/carolan.

Social networks are typically composed of who knows whom, who is friends with whom, or who talks with whom, the different types of ties just discussed. For example, consider Figure 1.1, which shows a hypothetical network based on friendship preferences in a class of 25 elementary school students. Suppose students were asked to list their top three friendship preferences, with each of the three nominations receiving a 1,

0 otherwise. These relations are mapped using widely available social network analysis software, reviewed in the book's final chapter. These maps of social networks are referred to as sociograms and are useful tools to identify certain network properties. Each circle represents an actor, which in this case is a member of an elementary school class. The lines connecting them represent friendship nominations; more specifically, each line connects a pair of students. In this example, the network consists of all 25 class members. This is referred to as the network's boundary.

In this example, the lines are directed; therefore, the arrow shows the direction of the friendship nomination. The thickness of the sociogram's lines does not indicate anything, but it is possible to make sociograms that vary line properties to represent the strength or type of relation. In this case, however, the relationship is either present or absent (binary); the relationship's strength has not been measured. Sociograms are usually constructed in a way that actors who are most central are in the center and their ties are placed near them. For example, Students 19 and 24 appear to receive more friendship nominations than others; hence their central location. There are many ways to arrange actors in a sociogram, as there are many ways to represent actors or their ties. Up to four attributes of each actor can be layered onto the sociogram by altering the color, shape, label, and size of the symbol. For example, boys are denoted as circles and girls as squares. The attributes of the ties can also be altered by adjusting the size and style of the line connecting each dyad.

Central to social network analysis is the contention that one's location in a social structure shapes one's opportunities and outcomes. These locations are referred to as positions, and most people are first interested in figuring out who is at the center. But just as there are numerous ways to define one's position in a network, there is a number of varied ways to determine who is at its center. These dual notions of centrality and position are discussed in Chapter 5. As interesting as it may be to determine which student is most central, it may also be interesting to find out who is on the periphery (those with few ties, for example, Students 10 and 20, who do not receive any nominations) or those who are isolated (those with no ties). While you might assume that being on the periphery of a network is disadvantageous, often these peripheral members have ties to other people within or external to the network in which they may occupy important positions. In these instances, the actor serves as bridge to other groups or networks.

In addition to using characteristics such as gender, it is also possible categorize actors as being members of specific subgroups. However, unless you rely solely on exogenous attributes such as gender or age, defining what constitutes group membership is tricky. Social network analysts have devised a number of ways to partition a network into groups, and these ways are reviewed in Part II. These methods are distinctly different, as they are based on relations rather than on the attributes that one may share with others. In addition, networks can also be divided into distinct positions (also discussed in Part II). Positions are different from groups in that actors who

occupy similar positions have similar relations to others but need not be directly tied to each other. Consequently, actors may be identified as being in the same group but in different positions, and vice versa.

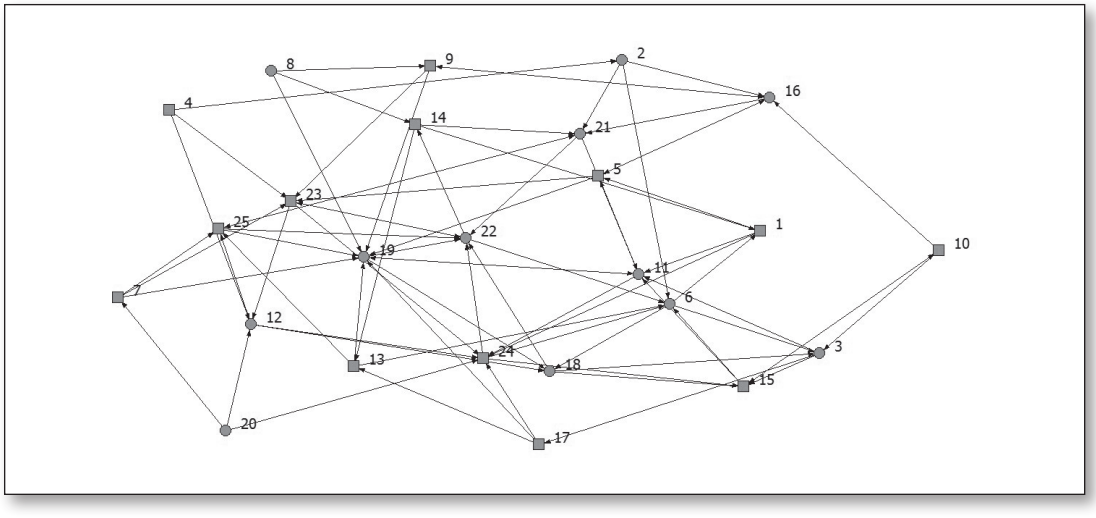
This book equips you with the theory and methods used to analyze networks such as the one presented in Figure 1.1. Moving beyond static snapshots such as this, social network analysis also allows you to learn about how attitudes and behaviors spread through networks over time. In other words, do one's friendships change? Does the entire network become more centralized? How rigid is the network's hierarchy? Better yet, assume that in addition to relational data, one also has data on individuals' attributes, such as grade point average. Now, you could ask questions such as, how does being on the outside (periphery) or inside (center) of a friendship network correlate with one's grade point average? Or, do birds of a feather flock together? That is, are students with similar grade point averages likely to nominate each other? Understanding concepts such as centrality, bridging, groups, positions, and homophily enables you to measure and predict how a friendship network changes over time and how these changes relate to outcomes that are of interest to educational researchers. Chapter 5 explicitly addresses this issue by discussing how resources flow through networks over time and how this process influences individuals' behavior or attitudes.

The overall pattern of relationships represented by the sociogram can also be important. Whereas researchers are at times concerned with individual outcomes such as whose friendships remained stable over time, other times the concern may lie with the structure of the entire network and how this pattern evolves over time. Although an individual actor's relations affect his/her opportunities and outcomes, the influence of these relations is shaped by the larger network in which the ties between any two actors are embedded. This pattern is referred to as network structure, and this structure matters in terms of shaping how and when resources flow across the network. For example, the network structure in Figure 1.1 can be described in very concrete ways. Some of these ways include density (the number of ties divided by the total number of possible ties), centralization (the extent to which the ties are focused on one or a few actors in the network), or the number of subgroups (there are numerous ways to identify these). A detailed description of these static complete network properties is presented in Chapter 5.

WHY NETWORKS MATTER IN EDUCATIONAL RESEARCH

The interest in social network analysis across the social and behavioral sciences has grown tremendously in the past 20 years. As this interest has grown, educational researchers have drawn on its interdisciplinary foundations to study a range of phenomena. A brief history of these foundations is presented in Chapter 2, with particular

Figure 1.1 Hypothetical Friendship Network of Elementary School Children Within the Same Class (N = 25). Friendship ties are binary and directed. Square nodes represent girls and circles represent boys. Graphs of complete networks such as this can reveal several interesting network properties, including whether relations are dense or sparse, centralized or decentralized, or whether any individual members occupy strategically advantageous positions.



attention given to the advances in the field made by those who have studied educational phenomena. Many topics that have attracted interest from educational researchers can be considered from the social network analysis perspective. Some examples include:

- Diffusion and adoption of innovations (Daly & Finnigan, 2010)
- Social influence (Cole & Weinbaum, 2010)
- Belief systems (Frank, Kim, & Belman, 2010)
- Social capital (Maroulis & Gomez, 2008)
- Homophily (Coburn, Choi, & Mata, 2010)
- Efficacy of interventions (Valente, Hoffman, Ritt-Olson, Lichtman, & Johnson, 2003)
- Small-group dynamics (Katz, Lazer, Arrow, & Contractor, 2004)
- Small-world and scale-free networks (Carolan, 2008a)

These examples reflect the pervasiveness and variation of network-related phenomena. A few of these specific social network phenomena are discussed at length

in the book's third and final section, with a focus on the ways in which these network phenomena have been modeled and applied in the educational research literature.

While educational researchers have studied several of these phenomena for quite some time, what distinguishes the studies referenced above is that the explanation includes concepts and information on relationships among actors. As noted by Wasserman and Faust (1994), the social network perspective consists of theoretical concepts that are relational, data are relational, and critical tests of statistical significance use distinct distributions of relational properties. Whether you are interested in the influence of a school's social structure on an individual actor's achievement, or whether certain opinion leaders are critical to the adoption of a reform initiative, social network analysis operationalizes these patterns of relationships in terms of networks and ties among actors. This perspective differs significantly from the ways in which individual or group behavior is typically conceptualized and modeled in conventional educational research. Standard practice usually ignores relational information.

Several hypothetical examples illustrate this. Imagine you are interested in students' behavior in the first year after transitioning to a new middle school, a critical turning point in adolescents' educational trajectories. The first step in the standard approach would be to define a population of interest (fifth-grade students who moved to a destination middle school), assuming a large population, take a random sample, and then collect data on a number of relevant variables (e.g., academic history, socioeconomic status, disciplinary history, sex, etc.). The assumption here is that one student's behavior is independent of any other's. Social network analysis directly confronts this assumption. Anyone who has spent time with early adolescents knows that their behavior shapes—and is shaped by—the influences of others. Moreover, there are many factors that influence the way adolescents behave the way they do (such as attending school on any given day, disrupting the class, etc.). Adolescents often tend to turn to others and either mimic behavior or "act out" in ways to seek approval from select audiences. To best fully capture a description of the student's behavior, you should examine student-to-student relations. These relations might include membership in the same extracurricular groups, the frequency with which they communicate outside of school, joint course-taking patterns, friendship nominations, and others. To fully understand and model the phenomenon of student behavior, you need the relational data inherent to the social network perspective.

Another example illustrates the importance of relational data and how conventional practices do not adequately account for or model these influences. Suppose there is a group of teachers making a decision or trying to reach a consensus. The group may be assigned to select an appropriate textbook for the school's ninth-grade social studies curriculum. Most would be interested in the outcome of this process—what decision has been reached. But focusing solely on the outcome ignores the complex process through which the outcome was generated. One should really look into how members of the group influenced each other in order to make a decision, or, perhaps, not make a

decision. The social network perspective allows you to systematically model how these interactions among group members led to the outcome. The influences of any one member are quite critical to the process, and by ignoring them, researchers leave themselves with an incomplete picture of social life. After all, social life is relational, but most social science does not account for these relations.

The reasons for this are varied. But the inability to account for social relations, at least among educational researchers, can be traced to the historical preference for actor-by-attribute data. This refers to the fact that many of the interesting social phenomena that have been examined by education researchers—say, whether a school administrator successfully implements a whole-school reform initiative—have been studied using a framework that removes the actor from its relational context. In this example, the actor is the administrator, who has a number of different attributes that make him or her more or less likely to be successful. These attributes may include one's personality, experience, competence, status, and so forth. This is what is meant by the term *actor-by-attribute*. But what missing from this picture are the relations that this administrator has with others who are critical in shaping how the reform plays out. With actor-by-attribute data, all you have is a set of independent actors, often treated as rows in a data file, who have certain attributes on a number of relevant characteristics, typically organized as columns in the data file. This is the "sociological meatgrinder" in action, removing the actor from his or her social context and assuming that the actor does not interact with anyone else in the study (Barton, 1968, as cited in Freeman, 2004).

Because the social network perspective emphasizes the importance of relational data, the way in which one approaches social network data is upended—the actor-by-attribute approach is conceptually and analytically inadequate. This is an issue discussed in Chapter 4, which focuses on the collection and management of social network data. The collection and management of these data, however, are premised on the idea that actors' characteristics arise out of structural or relational processes. This premise is established in Chapter 2, where the focus is on how the social network approach developed in a way that challenged the conventions that rigidly constrained researchers across the social sciences. Social network analysis and its earliest adherents took on the task of understanding properties of the social structural environment and how these properties influenced observed characteristics and associations among these characteristics. After all, life in and around schools is relational; it's only because, for example, high achievers and low achievers occupy particular kinds of patterns in a school's network in relation to each other that "achievement" becomes an important analytical focus.

RECENT ADVANCES IN SOCIAL NETWORK ANALYSIS

As the importance of relations becomes more widely recognized across the social sciences, the use of social network analysis has grown, especially among educational

researchers, a point illustrated at the beginning of the following chapter. The reasons for this growth are varied and have their foundations in a number of advances made in disciplines and fields as diverse as computer science, mathematics, sociology, economics, and public health. These foundations are also discussed in Chapter 2, which presents a succinct review of the historical and theoretical foundations of social network analysis, giving special attention to the contributions of those who have studied educational phenomena through a variety of different disciplinary lenses. As this research has grown—and has become increasingly transdisciplinary—a number of noteworthy and significant research and development areas have been established. This section describes a sliver of theses areas in which social network analysis has made much progress. These recent advances have several implications for educational researchers interested in employing the social network perspective in their own work.

Visualization Techniques

The visualization of social networks has been a core practice since its foundation more than 90 years ago and remains a hallmark of contemporary social network analysis. These images of networks, both static snapshots as well as their evolution over time, are commonly created to develop structural insights and to clearly communicate these insights to others. The use of images to convey social network properties and dynamics experienced three periods of rapid innovation (Freeman, 2004). First is the hand-drawn sociograms developed by Jacob Moreno (1934) to represent relations among children in school. These early images paved the way for the computational approaches for plotting a graph's points and lines. This early history, discussed in more detail in Chapter 2, established the principle that the visualization of social networks communicates the spatial representations among actors and should depict pairs that are proximate in a data matrix as proximate in the image. That is to say, images of social networks should reflect the underlying data. The second phase of innovation moved beyond hand-drawn images and relied on mainframe computers and software to automatically produce graphs. This period throughout the 1960s formally integrated graph theoretic principles into the production of social network imagery. The third and most explosive phase, starting in the mid-1990s and continuing today, does not just produce static images of networks at one point in time but also allows networks to be visually represented as networks—and the actors and relations that constitute them—change over time. Made possible by computational speed, power, and convenience, the animation of both large and small social networks provides new insights into the dynamics that are often of interest to social scientists. A review of several popular network visualization applications as well as best practices in network visualization is provided in the book's final chapter.

Statistical Inference Using Network Measures

In addition to the recent advances made in the visual representations of social networks, there have been several critical developments made in the area of statistical inference of network measures. Most analyses of social networks are, in fact, descriptive (Knoke & Yang, 2008). These descriptive studies are able to make strong, empirically justified statements that demonstrate the static and dynamic properties that are at play within its boundary. These types of studies—and most social network studies fall in this category—aim either to represent the network's underlying social structure through data-reduction techniques or to characterize network properties through algebraic computations. Valente (2010) argues that perhaps the most significant development in social network analysis has been the development of exponential random graph modeling (ERGM), which is introduced in Chapter 9. Statisticians have developed the distributions behind network properties in a manner that has contributed to computer applications that permit the statistical testing of a network's dynamics and evolution. These advances have enabled social network analysis to move beyond description and toward inference: predictions about what will likely happen to a network over time. This set of developments is comparable to the advances more than 50 years ago in terms of understanding the logic of probability and its contribution to the field of inferential statistics. The advances spurred through the developments in ERGM are also introduced in the book's final section, with an emphasis on the p^* models and their ability to explain the presence of dyadic ties as a function of individual- and network-level explanatory factors.

Diffusion

In addition to advances in visualization techniques and statistical inference, both of which have implications for educational researchers, there are several research fronts on which much progress has been made. Diffusion is one of these areas in which researchers have made progress in identifying the structure and process through which attitudes and behaviors flow from actor to actor. Consider the following scenario in which networks play a key role in how an attitude spreads. There is a set of teachers whose relationships are described by a network, indicating who interacts with whom on a regular basis. Presume that any two teachers have a tie or not. Now, consider the introduction of a new student discipline policy. One teacher may enforce the policy if he or she interacts with another teacher who has also decided to enforce it. Also suppose that enforcement of this new policy occurs somewhat randomly, as the chance of interaction might be random and it also might take specific conditions for the enforcement of the policy to spread. Finally, also consider that the chance of any given teacher enforcing the policy increases with the number of others who enforce it. Under what conditions will

enforcement of the policy spread to a nontrivial portion of the network? What percentage of teachers will ultimately enforce this policy? How does this depend on the network's structure and the individual's position in that structure as well as one's own individual attributes?

This problem is of obvious importance and relevance to a range of educational phenomena beyond this hypothetical example, including information transmission, opinion formation, reform implementation, participation in programs, and other behaviors. Cutting across studies in diffusion (also referred to as *contagion*) processes is the idea that one's adoption of an attitude or behavior is strongly influenced by the networks of which that person is a part. A more detailed chapter on diffusion theory and how it relates to educational phenomena can be found in the book's third and final section.

Learning

Another research front on which social network analysis has been applied is learning, which is very much connected to the ideas and models used to study diffusion processes. Educational research typically treats learning as an individual outcome, ignoring the messy relational processes through which you form an opinion or an understanding on a topic of interest. Social networks obviously play a central role in the sharing of information and formation of opinions. This is true in the context of one advising their peers on how to solve a math problem, relaying information about what is on the upcoming science exam, evaluating one's merits for inclusion in a peer group, or simply providing information about the location of a classroom. Networks play a key role in shaping opinions, beliefs, and understandings and ultimately in shaping behaviors. Therefore, it is important to have a thorough understanding of how network structure affects learning of all sorts (Jackson, 2008).

Some fundamental questions relevant to educational researchers concern how social networks influence:

- whether students come to hold a common belief about the school or remain divided in opinions;
- which teachers have the most influence over other teachers in the school;
- how quickly students learn; and
- whether understandings on course-related material scattered widely across the class can be aggregated in an accurate manner.

Various answers have been given to these questions, and the book's final section explores some of the basic models that have recently been developed in attempt to provide answers.

LEVELS OF ANALYSIS

Because relationships are the main focus of questions such as those noted earlier, as well as others that lend themselves to the social network perspective, these relationships must be captured in measurement and data collection. There are four distinct levels at which to measure and collect social network data, and this decision is made after you choose the sampling units and relations. Details about the selection of sampling units, relations, and appropriate measures and methods appear throughout the chapters in Part II, but here is a brief summary of the four analytic levels on which you may focus.

First is the egocentric network, which is the simplest level, consisting of one actor (ego) and all the other actors (alter) with which ego has direct relations, as well as the direct relations among those alters. This is referred to as ego's first-order contacts (e.g., friends), in contrast to second (e.g., friends of friends) and higher orders consisting of all the alters of ego's alters, and so forth (Knoke & Yang, 2008). Each ego actor can be described by the number, frequency, and other characteristics of its ties with its set of alters, for example, the density of the ties among its alters (the number of ties present divided the number of possible ties). For example, take a random sample from a population of interest—say, parents who belong to schools' parent–teacher associations—and then ask each (ego) to generate a list of names of other parents (alters) from whom they seek advice about school matters. Then, ask each ego about the nature of his or her relationship with each named alter (e.g., Is this parent's child in the same grade as yours?). You might also want the ego to provide characteristics of the each alter, including gender, age, race, and so forth. The analysis of such ego-level data can therefore focus on questions such as the tendency for parents to seek advice from those who are similar to themselves with respect to an attribute such as socio-economic status (homophily) or whether those egos with high levels of network closure have a better ability to monitor their children's behavior (social capital). This analytic level has elements of both attribute-based social science and relation-based social network analysis (Borgatti & Ofem, 2010). Because of these shared elements, egocentric network research designs are well suited to traditional surveys of respondents who are unlikely to have contact with one another (independence of observations). The 1985 General Social Survey was the first large-scale survey effort that include a battery of items that asked about an ego's alters. More recently, the Educational Longitudinal Survey of 2002, as well as its predecessor the National Educational Longitudinal Survey of 1988, also included a set of questions that asked respondents (egos) about their relations with alters as well as the attributes of those alters.

The next two levels of analysis shift the focus from the ego to the dyad and triad. First, a dyadic network consists of a pair of actors, and the most basic question about a dyad is whether a tie exists between any two actors, and, if so, what are its duration, strength, and frequency? Typical analyses at this level explain change in dyadic relations as a function of the dyad's characteristics, for example, whether friendships between pairs of students split upon transitioning to a new school. Second, triadic analysis focuses

attention on groups of three actors. Pioneering work in social network analysis focused on this analytic level and was initially supported by Simmel's (1908/1950) contention that, from a sociological perspective, groups of three are much more interesting. For example, all possible combinations of present and absent ties among three actors generate a set of 16 distinct triad types. An elementary question for empirical social network analysis is the distribution of observed triads among the 16 types, a summary tabulation that is referred to as a triad census (Chapter 5). Research in these triadic structures has focused on sentiment (liking, friendship preferences, animosity), with a concentrated interest in balance and transitivity (i.e., if A likes B and B likes C, does A also like C?).

The fourth level is the one that resonates most closely with what you typically consider social network analysis. Moving beyond the three microlevels noted above, the complete (also referred to as *whole* or *full*) network level focuses on a set of actors and the ties among them in a bounded sample. Working at this level, you select a set of actors to serve as the population for study. Then a few types of ties are measured for each pair (dyad) in the population. For example, you might be interested in a school's teachers and, for each pair of teachers, determine whether they seek help from one another or whether they interact outside of school hours. In this approach, the population of actors reflects some type of group, whether that group is self-defined, such as a group of friends, or an externally defined group that shares some trait or common role, such as teachers in a school.

In general, this approach does not sample in the sense of drawing a random number of respondents from a large population. However, this approach does not necessarily result in a network that is connected (i.e., there is a path of ties from every actor to every other). Instead, what is likely to happen is that the network is split into components: groups of actors that are connected, but these groups are not connected to each other.

There are several strengths of working with complete network data. First, complete network data provide you with an opportunity to examine individual actors, groups of actors, or the entire network. The different constructs that you may measure at each of these levels are discussed in Chapters 5 and 6, which focus on the different ways in which network researchers measure important constructs such as centrality, connectivity, groups, and so on. A second strength of whole network data is that they can incorporate rich contextual information that can be used in subsequent analyses. So, in examining a whole network of teachers in one school, you may want to consider the context in which these relations are emerging, enduring, and receding, especially as the school year progresses and issues arise that trigger these relational changes. There are also several challenges when working with complete network data. The thorniest of these is missing data—the bane of any quantitative researcher. The ways in which social network analysts deal with this issue are discussed in Chapter 4.

It is important to keep in mind the theoretical and analytical distinction among these four different levels of analysis. This distinction will be made clear throughout the text. However, much of what will be presented focuses on the ego and complete levels, as most questions relevant to educational researchers are best addressed at these two analytical levels.

ORGANIZATION OF THE BOOK

This book is organized in a manner that is intended to introduce you to the social network perspective and how it may influence the way in which you approach the study of a range of educational phenomena. The book's organization flows from this objective. Chapter 2 reviews the theoretical and historical foundations of social network analysis, with an emphasis on its use as a powerful tool for empirically studying the dynamic and processual view of schooling that is central to educational theory (McFarland, Diehl, & Rawlings, 2011). Chapter 3 introduces the basic ways in which network data are represented, and the following chapter details how these data are collected, managed, and processed prior to analysis. Throughout both of these chapters, you will be introduced to a variety concepts and notation from graph theory and sociometry. Much care has been taken to gently guide you through these principles without letting oversimplification result in distortion. The mathematics in which this notation is employed comes into play in Chapters 5, 6, and 7, which address issues of what networks "look like" and how they "work." The book's remaining chapters integrate a number of the core issues and ideas that were introduced in the preceding four chapters. This final set of chapters demonstrates how social network analysis has been and can be used to study a variety of different processes that are of interest to educational researchers. The goal of this set of chapters is to provide you with a framework that can be employed in your own work in related research areas.

The progression of the text moves from simple to complex, so it is best to read this text from front to back. Also, given the complexity and richness of the material, I have kept the chapters as succinct as possible. This brevity is in recognition of a number of top-notch general social network analysis texts that go into this material in greater depth. You are encouraged to consult these materials; every effort has been made to direct you to these sources. The final set of chapters focuses intently on one substantive area of educational research that has been studied by numerous researchers using the social network perspective. Here, too, you are encouraged to consult the original sources for details about specific studies that may have been overlooked while trying to maintain the book's intent of serving as an introductory text.

DATA SETS

A small number of network data sets are used throughout the text to illustrate various concepts that are central to social network analysis. Background on each of these data sets is provided, especially the measurements on all relations and individual actor attributes. These data sets are varied but reflect the types of issues that may be of

interest to educational researchers. In addition, these data sets are freely available through this book's online supplement and have even been used in a number of published research studies.

Newcomb's Fraternity Members

These "classic" data were originally collected by Theodore Newcomb (1961) from 1953 to 1956 and consist of 15 matrices that record weekly sociometric preference rankings from 17 men attending the University of Michigan in the fall of 1956; data from week 9 are missing. They are also available in UCINET (Borgatti, Freeman, & Everett, 2006), a popular general social network software package reviewed in Chapter 12. A 1 indicates first friendship preference, and no ties were allowed. The men were recruited to live in off-campus (fraternity) housing, rented for them as part of the Michigan Group Study Project supervised by Newcomb. All were incoming transfer students with no prior acquaintance with one another.

Pittinsky's Middle School Science Classroom Friendship Nominations

Collected from students in four middle school science classrooms taught by the same teacher at two points in the school year, these data (reported in Pittinsky & Carolan, 2008) provide opportunities to examine two interesting features of students' social networks. First, because network data were collected in the fall and spring, it provides an opportunity to examine how within-classroom friendship patterns change over time. Second, not only were students asked to nominate their friends, the teacher was also asked to rate who was friends with whom. This provides an opportunity to examine how well the teacher perceived friendship patterns among students and the degree to which this accuracy increased or decreased over time.

Daly's Network of District School Leaders

The third data set used throughout this text is Daly's Network of School District Leaders. Leadership network data were collected at two school districts over 3 consecutive years. For each consecutive year, school district leaders were invited to complete a survey that collected individual demographic information (e.g., gender, ethnicity, marital status, age, years of experiences), 11 different network relationships (e.g., collaboration, confidential, energy, expertise, support you approach, support approach you, work-related issues, input, recognition, best practices, and innovation), efficacy,

and trusting relationships. The social network questions asked the participants to assess the frequency of interactions they have with those nominated individuals on a four-point frequency scale ranging from 1 (the least frequent) to 4 (1–2 times a week). The efficacy items were designed based on the Principal Efficacy Scale used in Daly and colleagues (2011) and Tschannen-Moran and Gareis's (2004) studies. The efficacy scale includes 18 items rated on a 9-point Likert scale ranging from 1 (None at all) to 9 (A great deal). The trust scale contains eight items rated on a 7-point Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree) modified from Tschannen-Moran and Hoy (2003).

SUMMARY

The social network perspective introduced in this chapter provides a brief introduction to a number of concepts and applications to be discussed throughout the remainder of the text. While targeted toward aspiring and current educational researchers, as well as those who are charged with shaping educational policies and practices, this text will cover a range of research topics that are germane to the field of education. While these topics are diverse—peer influence, social capital, the diffusion of innovations, for example—they all share an emphasis on relations and how these relations can be conceptualized, measured, and analyzed without stripping the individual from the context in which those relations play out. The remainder of this book is dedicated to this focus. In particular, the remaining chapters of this book are dedicated to answering the following question: *How does an understanding of social networks help you make sense of educational opportunities and outcomes at the individual and aggregate levels?* This focus on the distribution of opportunities and outcomes has been a central focus of educational researchers for some time, yet, curiously, the theoretical and analytical tools that they have employed have neglected the relations among actors in context. The remaining chapters redress this shortcoming.

CRITICAL QUESTIONS TO ASK ABOUT THE SOCIAL NETWORK PERSPECTIVE AND ITS USE IN EDUCATIONAL RESEARCH

1. To what degree does the study emphasize one or more of the following: (1) individuals and their actions are viewed as interdependent; (2) relational ties between individuals are opportunities for transmission of resources; (3) the pattern of relations among individuals—the social structure—is an environment that can provide either opportunities for or constraints on individual action; and (4) social structure as an enduring pattern of relations among actors?

2. At which level are the social network data measured and collected: ego, dyad, triad, or complete?
3. What relations have been measured among actors? Why were these relations measured and others excluded?

CHAPTER FOLLOW-UP

1. Consider a network of which you are a part. Who are the network's actors? What ties connect these actors? Are there any groups within this network? What relations within this network might be of interest to a researcher? Finally, what makes this collection of actors a social network?
2. Draft a research question that would be of interest to educational researchers that would require the collection of relational data. What relational data would need to be collected? For what reason would relational data need to be collected in order to address this question?
3. Using the same question from the previous response, explain the analytical level at which these data would need to be collected and analyzed.

ESSENTIAL READING

Borgatti, S. P., & Foster, P. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991–1013.

Daly, A. (2012). Data, dyads, and dynamics: Exploring data use and social networks in educational improvement. *Teachers College Record, 114*(11). Retrieved from http://www.tcrecord.org/content.asp?contentid=16811

Watts, D. J. (2004). The "new" science of networks. *Annual Review of Sociology, 30*, 243–270.