

Methodological Transactionalism and the Sociology of Education
Daniel A. McFarland, David Diehl and Craig Rawlings (Stanford University)

Abstract: The development and spread of research methods in sociology can be understood as a story about the increasing sophistication of tools in order to better answer fundamental disciplinary questions. In this chapter we argue that recent developments, related to both increased computing power and data collection ability along with broader cultural shifts emphasizing interdependencies, have positioned Social Network Analysis (SNA) as a powerful tool for empirically studying the dynamic and processual view of schooling that is at the heart of educational theory. More specifically, we explore how SNA can help us both better understand as well as reconceptualize two central topics in the sociology of education: classroom interaction and status attainment. We conclude with a brief discussion about possible future directions network analysis may take in educational research, positing that it will become an increasingly valuable research approach because our ability to collect streaming behavioral and transactional data is growing rapidly.

INTRODUCTION

In recent years Social Network Analysis (SNA) has become increasingly common in numerous sociological sub-disciplines, the result being a host of innovative research that tackles old and new problems alike. Students of the sociology of knowledge, for example, use networks of journal co-citations as a novel method for tracking the diffusion of new ideas through the academy (e.g., Hargens 2000; Moody 2004). Political sociologists are drawing on SNA to understand the dynamics of collective action (Diani 1995; Tarrow 1994). Organizational sociologists use formal and informal work networks to study organizational learning (Hansen 1999; Rawlings et.al. 2010; Reagans et. al. 2004; Singh 2005). And educational sociologists apply social network methodologies in their study of teacher communities, classroom conduct and learning (Bidwell and Yosumoto 1999; Frank et al 2008; McFarland 2001; Pittinsky and Carolan 2008). In this chapter, we focus our attention on educational sociology and relate how SNA has the potential to substantially reshape the future of this subfield.

Generally defined, SNA is the statistical study of the structure of interaction as it occurs between persons and / or other social units. The goal of most SNA is to understand how these configurations of relationships relate to some phenomenon of interest, such as actor behaviors or attitudes. The last several decades have witnessed an explosion of awareness about networks, not only within various parts of the academy as discussed above, but within the larger cultural consciousness as well. It is now common to colloquially speak of one's social network because of the ubiquitous use of networking platforms like Linked-In or Facebook as well as the new array of social media affixed to cell phones. This consciousness about networks has spread to educational phenomena,as

well, such that it is now common for educational practitioners and stakeholders to discuss networks when managing teacher professional communities (Penuel et al 2009; Wiley 2001), school redesign networks (Daly and Finnigan 2010), cyber-bullying (Kowalski and Limber 2007), and the integration of technology into schools (Frank et al 2004). We believe that the growth of network thinking in educational research will only continue, but before elaborating on how we imagine this will look, it is worth beginning with a brief discussion of *why* it is that networks have become so popular in recent years in order to help clarify exactly what the potential research value is.

There are several reasons new inferential methods are advanced and adopted, each of which is evident in the particular case of SNA. The first reason is that new methods are developed to help answer what would otherwise be intractable problems related to foundational disciplinary theory. While SNA is becoming an increasingly interdisciplinary endeavor, it was largely developed within sociology and anthropology (Wasserman and Faust 1994: 10-16). This is not a coincidence as SNA and sociology share the goal of explaining important social phenomena in terms of how particular units (such as people) are embedded in interconnected systems. This view extended to education early on as well, and one can find many early empirical works in SNA that studied relationships in classrooms (Almack 1922; Wellman 1926).

Within both SNA and sociology, however, there has always existed a gap between their theoretically informed vision about the nature of social process and the ability to capture them empirically. While some have argued that paradigmatic statistical methods, especially general linear modeling, distort sociologists' view of the world (Abbott 1988), there is a long history of scholars cautioning that many of the basic assumptions of

common methods, such as independence and normality, are at odds with classical theory's description of social reality (Emirbayer 1997; Martin 2003). Many methods common today were originally advanced precisely to help close this gap between theory and empirical reality. The development of hierarchical linear modeling offers a good example of this (Bryk & Raudenbush 1992). Standard linear models assume independence among actors, but this clearly is not the case when studying students who are nested in classrooms, which in turn are nested in schools. By allowing variance to be measured at multiple levels, hierarchical linear modeling presents a method more in line with our understanding of how schools are actually structured.

Similarly, SNA was also developed as an alternative methodology for studying social phenomenon, but until recently its ability to fulfill this goal has been severely hindered by limitations of computational power and statistical methodology. Work in SNA has most commonly concentrated on small groups and static networks because network data are difficult to gather and smaller datasets have been all that could be computationally managed. Over the past few decades, however, statistical breakthroughs and substantial increases in computing power have allowed for the development of progressively more sophisticated techniques. SNA models can now handle millions of nodes and new methods for dynamic and temporal features of networks continue to be at the forefront of the field (Boyack, Börner, and Klavens 2007). Much of what SNA potentially offers sociology and the study of education, then, is a means for better capturing complex interdependencies and fluid dynamics than many current and more popular methods are able to.

It is worth asking, then, why did general linear modeling itself become so popular? Part of the answer is certainly that it proved itself capable of helping sociologists tackle many long-standing problems as discussed above. There is another reason as well, however, one having to do with the second motivation for creating new methods, namely the availability of new types of information. After World War II the social survey became the main source of data in sociology and the development and adoption of linear multivariate analysis was the result of the need to find more sophisticated ways to analyze them (Clogg 1992; Converse 1987). We can see a strong parallel here with the current state of SNA. Numerous changes in the contemporary world, perhaps again most importantly the growth of the Internet, have provided abundant new sources of rich data. Most of these data are relational in nature and new statistical tools are required for their analysis. In much the same way that survey research created the necessity for more complicated multivariate models, so too does our burgeoning ability to collect massive interdependent data sets increase the need for more sophisticated network techniques.

These two rationales for the development of new methods are interrelated. As statistical tools become more advanced and their explanatory power more evident, they come to be applied to a growing number of areas and problems. This in turn raises new questions, again often requiring the development of even more sophisticated tools in order to find answers. Through this iterative process SNA helps us refine and reconceptualize our very understanding of the social phenomenon we are interested in. We can see this happening within education as many emerging streams of research focus on network aspects of schooling processes. For example, network and relational thinking

is helping reframe teaching and learning by focusing our attention on the role of trust (Bryk and Schneider 2002), relations among teachers (Coburn and Russell 2008), and the effect of social capital on student outcomes (Morgan and Sorensen 1999).¹

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 our theoretical lenses in questions in light of social change – we expect SNA to become an increasingly central part of the sociology of education and bring about a paradigm shift from methodological individualism to methodological transactionalism. Throughout the rest of this chapter we make this argument using research on classroom processes and status attainment as substantive examples. More specifically, we argue that sociologists of education can adopt SNA and the network perspective in increasingly comprehensive ways. First, SNA can be used to **augment** topics by applying network variables and constructs in current statistical models. Here we add relational variables to standard models to better account for interdependencies.

Next, SNA can help us **reconceptualize** research topics reframing the phenomenon of interest in network terms. Generally, this means seeing complex social interdependencies not only as part of the explanation for some individual level outcome, but also as part of the phenomenon to be explained. That is, we come to reconceptualize educational processes as being understood in terms of the fluid and changing relationship between actors and the networks in which they are embedded. Finally, we conclude the

¹ The increase in network thinking in education is related to a growing sense in popular consciousness that we are moving into a more ‘networked’ world where interconnections and interdependencies are both longer and stronger. The result is that we come to understand a widening range of issues in terms of their network characteristics. While we certainly need to be on guard from over-reaching and seeing networks everywhere and in everything, current work has nonetheless alerted us to that fact that SNA can help explain a surprising range of social phenomenon not previously thought to be related to networks.

chapter with a brief and speculative discussion about how cutting-edge technological breakthroughs in methods for both collecting and analyzing network data hold the possibility for **revolutionizing** the field. Here we describe the potential impact of new methods like reality mining (Eagle and Pentland 2006) where technological tools are used to automatically collect features of human behavior. The results are massive data sets of actual instances of interaction that can be used to directly model patterns of transaction.

We begin with a discussion of how current data and methods in SNA can be deployed to augment and reconceptualize our approach to classroom processes – an important but somewhat understudied area in the sociology of education. We then move on to examine how the network perspective can inform our understanding of status attainment processes – an area at the core of the sociology of education, and one which can clearly be augmented with SNA, but where a network re-conceptualization may only become fully possible through future advances in data mining and computation.

NETWORK PERSPECTIVES ON CLASSROOM PROCESSES

Methodologically, the most common approaches to the quantitative study of classrooms have treated them as groups of isolated individuals whose behavior and attitudes are influenced by personal and family attributes on the one hand, and the characteristics of instruction, teachers and school organization on the other (Lubber 2003: 309). Yet the underlying statistical assumptions of independence are at odds with the implications of both sociological theory and diverse qualitative ethnographic work, each of which presents classrooms as complex interdependent social environments. Teachers and students simultaneously construct and are molded by the social context they jointly enact

through moment-by-moment social transactions (Wells 1993). This view is rarely captured, however, in the statistical methods typically used to study classroom processes.

By more thoroughly incorporating network perspectives and tools into the sociology of education, especially cutting-edge work on network dynamics, we argue that we will be able to better understand and study the interdependent relational processes that are the hallmark of classrooms. One of the central contributions of SNA has been the conceptualization of the individual's attitudes and behaviors as significantly related to the pattern of his or her relationships. Within SNA these patterns have generally been taken to be social structure itself (Freeman & Romney 1987: 310). Over the past 15 years, however, there has been a shift both theoretically and methodologically in the network research community toward a more dynamic and processual view of relational structures. This has entailed a growing interest in network change as well as in identifying the ongoing interactional micro-mechanisms that give rise to the formal properties of global level networks (e.g., Robins et al 2005). We think what is especially exciting about these developments is that as SNA becomes more sophisticated it allows us to quantitatively study the classroom in ways that match our current qualitative and theoretical view of them as interdependent and processual social contexts.

And so here we articulate two broad categories for how network analysis might be incorporated into our current study of classroom processes. These approaches differ in the degree they integrate assumptions of interdependence as well as the level of methodological sophistication they entail. In this way we can think of them as constituting a continuum that, as we travel across it, moves us progressively further away from our current variable-centric methods and toward more transactional models. On one

end network measures are used to study the distribution of some dependent variable on individual actors; on the other end network ties and individual attributes are modeled as changing in relation to each other through time.

Augmentation: Improving Individual-Level Explanations

We first look at the approach we refer to as *augmentation*. While not directly addressing issues of causation (which we will discuss in more detail in the next section), network data in an augmenting approach are used to create explanatory variables for use in standard regression models. The goal here is to use network measures to help explain variation in the distribution of some outcome measured at the individual level. This is probably the most common means of utilizing SNA in educational research because it can be done within standard models, thereby allowing the researcher to incorporate networks measures within a familiar and recognizable framework.

These individual level explanatory variables can be constructed in one of two ways. The first corresponds to what is referred to in SNA as the *relational* perspective (Burt 1980). Here the focus is on how individuals are affected by the behaviors and attitudes of the people they are connected to. Common to this approach are social influence and peer effects models that attempt to find the amount of influence that friends have on individual attitudes or behaviors. This work has shown, for example that an adolescent's level of delinquency is influenced by the delinquency of his or her friends (Haynie 2002) and that peers help shape stability and change in individual identity (McFarland and Pals 2005). Research in this area also looks at the affect of membership in sub-groups or cliques. Bidwell and Yasumoto, for example, found that shared norms in

teacher collegial groups are associated with higher student achievement (1999). In each of these examples we find the nature of relationships helps explain variation in what most studies treat individuals level attributes or behaviors.

The second general approach to constructing individual-level variables is based on measures of an actor's *position* in a network (Burt 1980). Here the importance of networks is seen not in terms of the characteristics of the people the individual is tied to, but rather in the location of the individual within the overall pattern of relationships (e.g., as bridge, as peripheral, etc). This is, perhaps, a less intuitive account of the importance of networks than the relational perspective. There are two reasons position in a network can be important. First, those in similar positions within or across networks may have similar attitudes or behaviors. Van Rossem and Vermande, for example, find that pre-schoolers in equivalent locations in classroom friendship networks have similar levels of school adjustment (2004). Second, there are advantages to being centrally located in a network, or in controlling positions through which important resources flow. In one well-know study, for example, Friedkin and Slater (1994) find that school-level standardized test scores were positively correlated with the centrality of the principal in the relational network of the school.

Reconceptualization: Explaining Relational Structures

While the augmentation approach helps us better understand the impact of networks on individual behavior and attitudes, we ultimately want to know how the connection runs in the other direction as well. That is, we want to understand not only how actors are influenced by the pattern of their embeddings in their networks, but also how the

individuals who compose it shape the structure of the network. One of the important emerging areas in SNA are methods for modeling global features of a network in terms of the probabilistic nature of underlying social and behavioral processes that give rise to it (Morris 2003). The methods for analyzing complete networks are less than a few decades old, most of them extensions of the p^* family of models (Frank & Strauss 1986; Wasserman and Pattison, 1996), more commonly known now as the exponential family of random graph models, or ERGMs (see Hunter et al 2008 for a detailed explanation).

The relative newness of ERGMs and related methods means that there is a scarcity of empirical studies utilizing them, but educational studies are quite well represented among the work that has been done. Research on both classrooms (Lubbers 2003) and schools (Goodreau et al 2009) has found that patterns of friendship are the result of individual preferences, group composition, and endogenous network processes like reciprocity and transitivity. The importance of such findings is that it shows that networks emerge out of complex and interdependent social processes, not just independent individual choices about ties. Most of our standard statistical tools cannot directly model this kind of interdependence.

Dropping independence assumptions and modeling tie formation directly helps us better capture interdependencies in classroom processes, but it does not deliver the fully dynamic view we are after. Such models cannot, for example, help us tease apart selection versus influence processes in tie formation, one of the stickiest issues in the study of behavioral dynamics (Baerveldt et al 2008). An assumption with ERGMs is that the network under study is at equilibrium but in reality most social networks are inherently dynamic, with ties constantly being created, maintained and dissolved

(Snijders 2010). To capture this empirically, we need to be able to simultaneously treat the network as both explanatory and dependent variable. This requires longitudinal modeling that captures how individual traits and interdependent relationships mutually influence and construct each other over time.

The longitudinal analysis of social networks has long been the “Holy Grail” for network researchers (Wasserman et al 2005: 6). It is only within the past few years that accessible methods for longitudinal network analysis have been developed. The most well-known of these methods are the stochastic based models developed by Tom Snijders and his colleagues available in the statistical package SIENA (Steglich, Snijders & West 2006). These models are essentially longitudinal ERGMs that combine regular panel data (e.g., individual attitudes) with network panel data (i.e., relational measures collected at separate time points). Importantly, even though network data in this work is generally measured at discrete intervals, the methodological assumption is that relationships are (potentially) evolving states that may change between observations.

This empirical work utilizing longitudinal network methods is just in its earliest stages, but early work on adolescent friendship networks is already beginning to tease apart selection and influence processes related to issues such as drug use (Pearson, Steglich & Snijders 2006) and smoking (Mercken et al 2009). In both cases the authors find that over time there is a process of both selection and influence as peers both seek out other ‘deviants’ as well as influence each others’ behavior. Existing work outside of the network tradition has already argued for this reciprocal relationship between selection and influence, but utilizing dynamic network analysis allows researchers to better specify the mechanisms at work and understand how they shape each other through time.

We end this section with a brief discussion about how dynamic SNA might help us reconceptualize the study of trust in schools. Recent research has linked trust to numerous important classroom and school outcomes, including the success of school-wide improvement efforts (Spillane & Thompson 1997), the fostering of a sense of community (Louis 2007) and student academic achievement (Hoy et al 2006). This is a case, however, where there is a mismatch between our theories about trust and the tools we use to study it. Conceptually, we do not think that trust directly affects the outcomes listed above, but rather that its presence shapes the nature of various types of interactions and behaviors. And so while relational trust is commonly defined as something that is “forged in daily social exchanges (Bryk and Schneider 2002: 136),” we have tended not to study it in terms of patterns of interactions but rather as an individual level variable collected through self-reports. These self-reports are often then aggregated to create a school-level measure of trust.

The result is a black-box where we know that trust shapes the nature of relationships in schools, but cannot say how trusting relationships emerge or identify the mechanisms through which trust fosters desired outcomes. Dynamic network analysis that models the co-evolution of individuals and networks offers the potential for opening up this particular aspect of classroom life. The key is in bringing together work on the characteristics of individuals and schools related to the presence of trust with research on the network evolution of social structure (van de Bunt et al 2005). By collecting data about both actor and institutional attributes as well as longitudinal network data we start to understand just *how* it is that trust matters and can begin to test hypotheses about possible causal mechanisms. Doing so is key if we hope to better understand how to

foster conditions in classrooms and schools that not only engender trust among teachers and students, but also maximize the link between trust and the outcomes we care about.

NETWORK PERSPECTIVES AND STATUS ATTAINMENT

We now move on to discuss how SNA can better inform an area at the core of the sociology of education (see Brint 2009). While there are fairly straightforward ways SNA has been incorporated into status attainment research to *augment* existing models, there are many frontiers within this new terrain that remain under-explored. Fairly straightforward opportunities to augment attainment processes abound, while more conceptual ways to think about attainment as broader “structuration” processes (Giddens 1984) in which individuals are both enabled and constrained by a complex network of institutional arrangements (Kerckhoff 1995) requires reconceptualizing how attainment research might be conducted. We are confident that because status attainment researchers have long been at the methodological frontier of the sociology of education SNA will become increasingly important within the core, although the more radical reconceptualizations may not take hold as quickly as in micro-level areas such as classroom dynamics with more clear affinities with existing network tools.

As a brief illustration of how we see new data and SNA tools poised to change attainment research, consider the early network analyses of adolescent social structure by Coleman (1961). These “sociograms” were painstaking to create because they relied on survey data and manual visualization. Compared with the relative ease of collecting rich network data from various online sources and the various data reduction and visualization techniques now available these early attempts appear heroic. Of course, the researcher

cannot simply rely on more advanced tools to provide an in-depth analysis; but these changes are not simply methodological in nature, and have opened up whole new vistas on “adolescent society” that are substantively important. If Coleman’s main point was that adolescents are living in greater isolation from adult society, this is probably nowhere more evident today than in various online social arenas. Clearly, many of the *relational* issues of peer-influence are taking place through digital media and SNA is poised to extract and analyze the “traces” of such relationships. New data sources and methods afford new opportunities to think about enduring questions of peer influences on students’ beliefs and behaviors that are central for achievement. While opportunities for augmenting existing models abound, getting at the broader structural conditions that create and re-create the fragmented institutions and alienation of adolescent society as a largely autonomous social world will require more creative use of broader network mapping techniques. In short, we are poised to elaborate and extend Coleman’s approach by collecting and comparing data on samples of adolescent societies’ social structures.

In what follows, we discuss these various issues in greater depth. We begin with a discussion of various attempts to augment attainment research using SNA. We then discuss how SNA affords a broader set of opportunities to reconceptualize this core of the sociology of education.

Augmentation: Networks and Individual Resources

Status attainment research has long epitomized the strengths of sociological approaches to agent-centered models – that is, models that incorporate social variables into explanations of an individual’s behaviors and beliefs. Since nearly its inception, this area

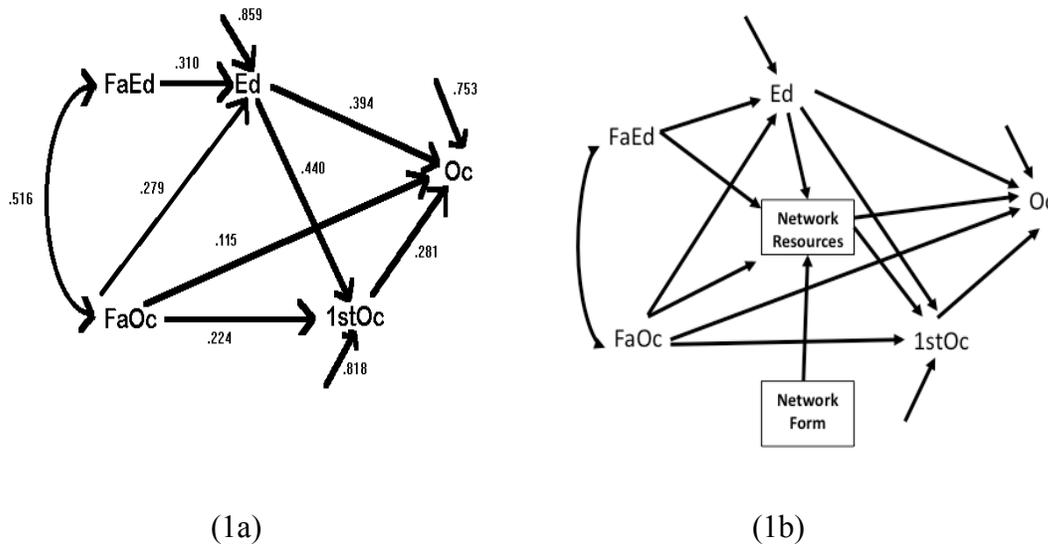
of research has also incorporated inherently relational social factors into explanations of achievement, although a shortage of network data and techniques for modeling such data for many years prevented a more nuanced way of getting at many of these processes. Researchers have necessarily approximated many relational effects using individual-level characteristics and standard regression frameworks.

The original status attainment model argues that an individual's family background characteristics tend to reproduce intergenerational mobility, but that years of schooling moderate the tendency towards social reproduction (Blau and Duncan 1967). The reproduction process – or rather, correspondence process – is even mapped out as a set of probabilities (Figure 1a). This was elaborated as the “Wisconsin Model” (e.g. Blau and Duncan 1967: 165-172) by augmenting it with relational influences (e.g. peer, parental, and neighborhood effects) to improve the overall “fit” of the predominant view of attainment.

At the same time that status attainment researchers were advancing these models, social network scholars were developing ways to more properly parameterize the formal properties of social structures. These scholars created sophisticated ways to model peer influence and reduce complex socio-metric data into graph-level indicators (e.g. network “density”, “clustering”, etc.). Through the structural features of such concepts as “social capital” – that is, parental social network closure – some of these concepts have been incorporated into models of individual student achievement (Carbonaro 1998; Morgan and Sørensen 1999). Yet the main strategy in this work is still that of incorporating network properties as individual-level characteristics. Only a few studies have approached education from a structural network perspective, as organized opportunities

to establish long-term connections with implications for attainment (Bergesen 2007; Stuber 2006).

Figure 1a and 1b. Wisconsin Model and Its Network Augmentation



Introducing measures of social capital or variables reflective of some structural location interjects a relational set of factors within the flow of attainment paths. Here one can introduce a variety of individual-based structural measures as independent and moderating variables to the standard OLS representation as an individual trait (as in many “ego-centric” network analyses) as opposed to a situational condition or conditional resource that depends on which third party is present (as in the formal study of “roles and positions”). In the social capital augmented version of attainment the factor salient to an outcome is the resource a network affords (Lin 2001; Sandefur and Laumann 1988). Hence, a student may have a dense group of friends, but if these friends expose the student to antisocial behaviors, the resources in that network will be of a different type than if they were high achieving students. In many peer-influence models, the effects of

such processes are modeled as “linear-in-means” – that is, influences from one’s associates are typically portrayed as a “mean on variable X” and used as an additional predictor of a given attainment outcome (i.e., attending college). This is often a first approximation of a more correctly weighted peer influence process (Friedkin and Marsden 1994).

Introducing the structure of one’s networks as a moderator allows the attainment model to become even more sociological and interesting, because it shows that attainment may not only rely on the *content* of network resources but also the *form* of network structures. The characteristics of individuals in networks are important in accessing important material and symbolic resources; however, the ways that these individuals come together to form a relational structure of ties is also central to various processes. In most models, the structural moderator of choice is most likely the *cohesiveness* of the friendship group (closure, closeness, cliquing, etc) (See Figure 1b; see Friedkin 1998 for review). The point here is that being situated within a dense group of friends or a popular group of friends may (1) intensify access to the resources and behaviors of those actors, and (2) serve as more enduring resources in the future because of the strength of such ties. There may be trade-offs in such moderator effects. For example, belonging to a cohesive group may be particularly advantageous in higher status settings, but particularly dis-advantageous in lower status settings; while forming many weaker ties may be helpful to the extent that it leads to connecting with individuals who differ in their broader connections (Granovetter 1973; Horvat et. al. 2003).

While such augmentations are proving informative, we are presented with a number of unmet opportunities to unpack questions derived from this literature: Are the

forms and contents of social networks more important than an individual's grades or other achievements in structuring status attainment? Does schooling organize opportunities for network formation and thus naturalize "social closure"? Do women and minorities have different network-formation "strategies" that may be implicated in subsequent differences in attainment?

Of course, in answering these questions we confront issues of causation so salient today in econometrics and currently being imported into sociology. For many classes of causal models the inter-unit dependencies and spillovers in social networks are violations of regression models' non-independence assumptions, while for a few scholars network effects are substantively important but difficult to estimate (Manski 1995; Jackson 2008; Rubin 1990). In peer-influence models, one wonders if students behave as they do because of their peers, or from factors that led them to associate with their peers in the first place? Ideally, we would have attitudinal measures preceding these networks that capture an individual's propensity for a certain belief or behavior, and then compare this to some change associated with exposure to a specific peer influence process. Of course, beliefs and behaviors are likely confounded with prior experiences with the peers of one's peers, so we may constantly have an infinite regress of reflected and reciprocal influence rather than a story of ultimate causal origins. And yet, longitudinal network models will allow for greater causal analysis along these various reciprocal chains and therefore represent exciting opportunities to disentangle various interdependencies and spillovers.

Estimating such models has become more sophisticated and capable of handling various aspects of social embeddedness. As Frank (1997) was early to notice, the advent

of multilevel models is particularly promising for allowing network properties to be incorporated within existing cross-sectional and longitudinal designs. Today, these advances have opened up a new frontier for better capturing a number of processes that are important for attainment research in education. Another approach often discussed is agent-based simulation (McFarland and Rodan 2009). What is nice about these characterizations of social phenomena like attainment is that they can relate a system of factors in explicit form (e.g., decision processes with their feedback loops, accruals, interdependencies). However many of these applications lack empirical grounding and merely reveal the limits of theories. Even when grounded in real data, we have more of a correspondence model of verification, much like a computer program can mirror the mind's output and appear like a person (e.g., chess computers, avatars, etc), but it is still not clear that it actually represents the way the mind works.

Ultimately, social network approaches may also afford a shift away from the strategy of incorporating relational characteristics into linear models of attainment processes towards a broader approach to the various social “landscapes” upon which individual attainment processes are carried out. Rather than focusing on augmenting an individual-centered model, network approaches afford a reconceptualization of attainment as an ecology of linked institutions. We discuss the potential for such a future shift in attainment research next.

Reconceptualization: Macro-level Opportunity Structures as Networks

Social network approaches tend to move beyond focusing on individual characteristics – even relational ones – to take into account the consequences of *positions* within a larger

network *structures* for various processes, especially those concerning the flow of various beliefs or behaviors (White, Boorman, and Breiger 1976). Positions can often be equated with “statuses” that imbue individuals with certain properties – both good and bad – that often have the property of being acts of “social magic” (Bourdieu 1984) or self-fulfilling prophecies (Meyer 1977). If we consider attainment processes as occurring within various “opportunity structures” that are properties of no single individual (Blau 1994), but of social contexts, then there is a natural affinity between network approaches and broader explanations of attainment (Small 2009). Stevens, Armstrong & Arum (2008) have recently called for this broader vision in studies of higher education by approaching colleges and universities as “hubs” through which “the economy, the family and the state intersect and are connected to other domains.” In this imagery, it is individuals who are “flowing” through a larger set of linked organizational and institutional structures – and in so doing, recreating these larger pathways.

This broader vision harkens back to the institutional roots of educational inquiry by showing attainment *as* patterned and networked. Early social theorists saw schooling as the predominant mechanism through which individuals are socialized and sorted into status positions. For Durkheim, the content of the schooling process was the central concern because it socialized individuals into functionally differentiated roles but also inculcated a broader sense of the moral underpinnings to the division of labor (Durkheim 1973). For Weber and Sorokin, the content of schooling was important, but was approached within a broader ecology of institutions (families, professions, states) that intersected in ways that legitimate various status groups (Weber 1968: 249; Sorokin 1959). These fundamental processes have been elaborated over generations of

sociological research. Theories of attainment contend that a variety of socialization experiences, institutions, and organizations tend to recreate status inequalities; however, the structures upon which attainment is carried out are rarely studied. The social network perspective is poised to reconceptualize status attainment approaches at both the intra-schooling and broader institutional levels in a manner that is more consistent with these earlier conceptualizations but also informed by later institutional and structural theories of attainment.

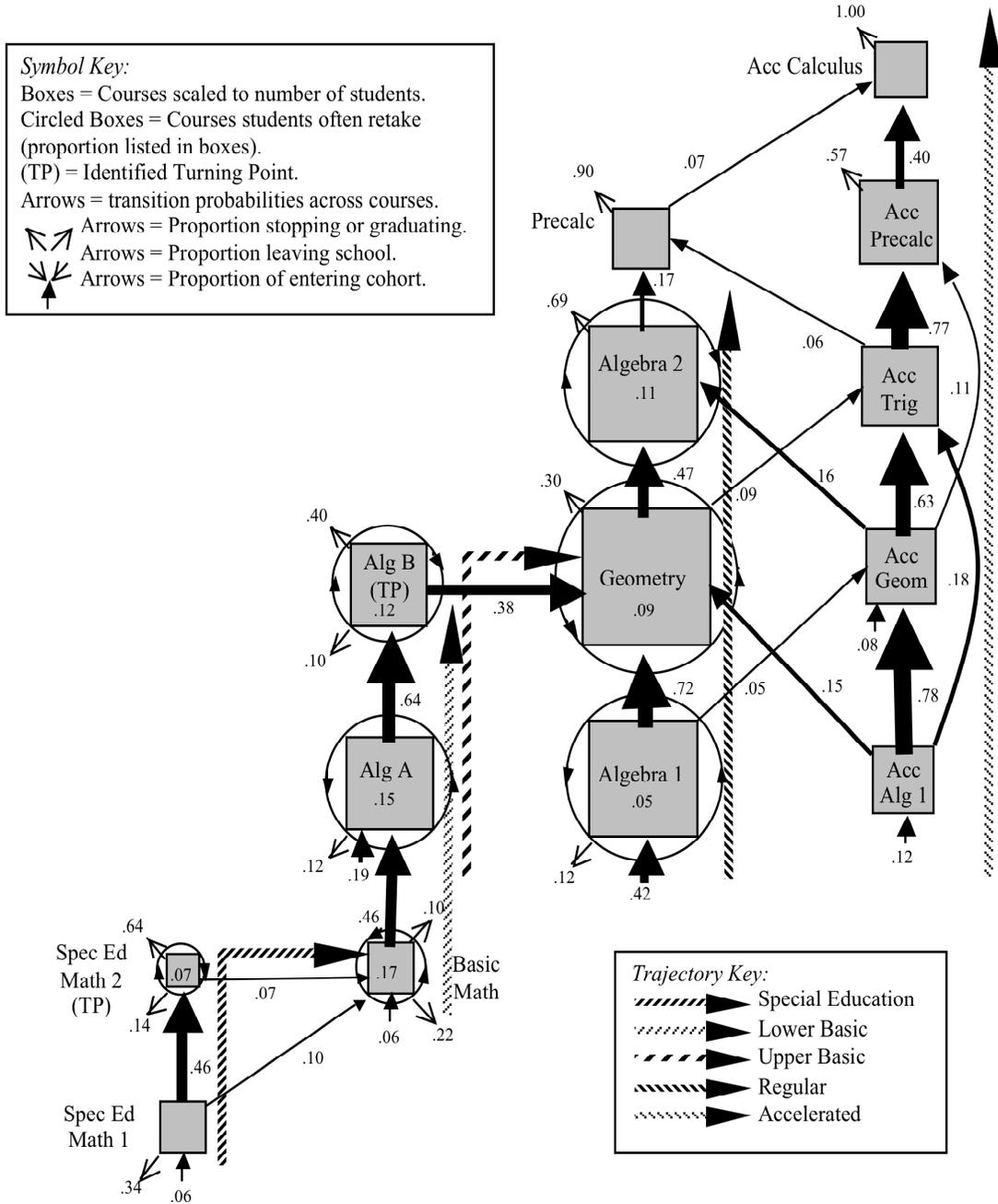
We propose that the metaphor of a cityscape – with a system of roads, origins, destinations, maps [knowledge], and types of cars [resources] – can be anchored in network concepts and analytical tools to better show how attainment unfolds through a set of individual decisions and happenstance that are situated within a fundamentally differentiated and linked institutional environment. Educational organizations are indeed “hubs” in a differentiated space, linking origins and destinations as well as numerous constituencies. Just as mobility can be situated within urban environments, which are structured so that opportunities are unequally distributed (Massy & Denton 1993; Small 2009), we can think of networks between organizations and institutions in formal terms. The network approach allows us to consider the formal properties of the ways that organizations and institutions are linked, how these enable and constrain individual mobility, and how in the course of moving through these structures that individuals either forge new paths or further pave existing ones. While augmenting existing individual-centered attainment models can provide a first approximation of many of these processes, especially in how they structure various life-course transitions (Fernandez and Weinberg 1997; Granovetter 1995), the broader cityscape metaphor is in many ways more

intellectually satisfying because it is inherently relational and deals directly with structuration processes – how individuals navigate through social structures and in the process tend to recreate these structures (Giddens 1984). Mapping this broader cityscape is becoming increasingly plausible.

This also draws our attention to the consequences of organizational and institutional differentiation for attainment. If social networks are structured in part by contexts of opportunity, then clearly “years of education” are not as important as *where* one goes to school, what one studies as one’s educational path – and how these opportunities are internally organized as well as externally linked to other institutional contexts. For example, the vast literature on “tracking” could benefit from this expanded metaphor and network approach. Students are indeed tracked, but we seldom *see* these tracks – how they are linked in intersecting trajectories with turning points, or how some are wider and are “fast tracks” to certain levels of attainments. Friedkin and Thomas (1997) and McFarland (2006) used network conceptualizations of course-taking to uncover such internal schooling pathways (see Figure 2). McFarland’s work reveals common pathways or highly traveled routes in different parts of the curriculum that have different speeds, volumes and points of confluence. Analyses of pathway mobility reveal that “traffic” matters and opportunities for movement are limited in certain positions, and that the “driver’s” resources in terms of experience and capacity for coursework also affect which pathway they can enter and remain within (McFarland 2006; McFarland and Rodan 2009). Advances in network approaches are making it easier to collect data and summarize the formal properties of such tracks. In addition to creating a richer *image* of the tracking process, we may be able to take a more variable-centered approach to

various tracks themselves and how these properties help channel students in certain directions.

Figure 2. Example of “City-Scapes” and “Traffic Patterns” in Attainment: Rural High from McFarland 2006



Mapping internal and external pathways and connections offers opportunities for understanding the broader landscape upon which attainment takes place – at the inter-organizational level we can ask which organizations are more central hubs and which are typical linkages in terms of important life transitions? There is a growing sense that various higher educational specializations have become increasingly linked to different occupational pathways (see Gerber & Cheung 2008 for review). As the *level* of educational attainment has increased, the number of qualitatively different routes to attainment have proliferated (Davies and Guppy 1997; Lucas 2001; see also Ayalon & Yogevev 2005). Differential access to specific college majors and unpaid internships may become more important as the roads to higher levels of education have widened for all. Mapping these networks of major highways and emerging back-road “shortcuts” to attainment stands to reveal more than correlations between origins and destinations, or studies of how networks structure a single life-course transition. Studies of “road networks” could offer greater insight into the complex institutional environments wherein individuals struggle for various forms of capital and exchange them for status rewards (Bourdieu and Passeron 1977).

Finally, rather than looking at such networks as static, we may examine macro-level linkages as dynamic structures. Institutional change sometimes affords the creation of new roads and destinations. For example, the creation of the land-grant system of colleges and universities provided a new set of academic roads (especially agriculture credentials) that helped create a number of professional destinations (Rawlings and Bourgeois 2004). Some of these new status destinations, including the occupation of professor in a land-grant institution, were of a level that was absent from rural American

life until the creation of the institution. The son of a sharecropper could well become a professor in a neighboring town. This suggests that the macro-institutional environment in which attainment takes place is constantly under construction, and information on new occupational destinations may be one particularly important source for first-mover advantages in attainment. That such information is contained within social networks that are themselves organized by schools is an understudied and potentially vital source of social reproduction.

Of course, many of the techniques for reducing complex images into sets of formal properties are still in their infancy. However, we believe an important frontier for future research will be to extend these more case-based approaches to more representative “samples” of different linkages in order to better understand the attainment implications for various hidden meso- and macro-level social structures.

A NEW EMPIRICAL WATERSHED—METHODOLOGICAL TRANSACTIONALISM

To this point in the chapter we have laid out not only an argument for the importance of social network analysis in the sociology of education, but also presented a continuum on which it can be used to both augment and reconceptualize existing research traditions.

We applied this to both the micro-level processes of classroom interaction and instruction and the macro-level issue of status attainment. In this last section we will talk about the final point on our continuum, the point where network theory facilitates a revolutionary rethinking about fundamental understandings in the sociology of education. More specifically, we argue, the frontier of network methods offers the possibility of empirically capturing the common-place but interactionally complex social phenomenon

in the inherently relational undertaking of education on both the proximal and distal levels.

There is a long history in the social sciences of seeing through network analysis, both theoretically and methodologically, a more processual and transactional view of the social world that could serve as an alternative to the variable-centered methodological individualism that now dominates (White et al 1976; Emirbayer & Goodwin 1994; Emirbayer 1997). When thinking about the future of social network analysis it is worth reflecting briefly on how methodological individualism came to hold the dominant position it now does. In the early years of sociology's disciplinary development there was a shared recognition that important social phenomenon were cultural, situated, and interdependent. This was (and still is) difficult to capture and early sociologists relied on formalisms like historical narratives and ethnographic accounts, and typically performed case studies of small groups, communities or firms. The difficulty of collecting rich qualitative data and the lack of statistical sophistication helped shape the kinds of questions these early sociologists asked as well as the ontological assumptions that undergirded them.

When the survey watershed took hold in the 1940s it dramatically altered the study of old sociological questions (Converse 1987; Platt 1996). By methodologically rendering individuals into atomic vessels of categorical attributes and social phenomenon as particular combinations of these atoms, some social scientists came to actually view the world in these terms (Abbott 1988). The approach was so widely performed that some even argued that the public began to view social reality in these individualized terms (Igo 2006). And yet, toward the end of this century, some of the leading

proponents of methodological individualism openly wondered if the approach should be adapted so as to recapture the social and communal aspects of educational life that had been so important prior to the survey watershed (Coleman 1994).ⁱ We have a story, then, of early sociology having limited means of data collection and a great reliance on narrative accounts that resulted in portrayals of social phenomena as situated communities composed of interdependent, culturally informed actors; and then a survey watershed which entailed the massive collection of individualized responses and reliance on statistical modeling that resulted in portrayals of social phenomena as aggregates of individuals and their central tendencies.

Now in 2011, we stand at the edge of another empirical watershed. With the advent of computing and the Internet we have witnessed data collection and storage techniques growing exponentially more sophisticated. Today, we are able to collect enormous bodies of rich information on the form and content of communicative transactions. The result of this new watershed, we posit, will be a diminishment of the primacy of methodological individualism and methodological transactionalism being placed on equal footing (Lazer et al 2009). In methodological transactionalism, dynamic networks and communication processes are the primary focus of data collection. Because transactions entail changing networks of communication, they can represent the duality of persons and groups (Brieger 1974). In effect, persons are intersections of transactions, and communities or groups are temporary equilibriums of aggregates. Hence, transactional data likely affords the means of bringing back early studies of groups and sustaining accounts of individuals while making room for changing situations and the communicative acts that form all of them.

But a reader might stop at this point and correctly remark that network analysis has long been touted as the new revolution that has never happened, so why is now any different? The most important development in recent years is simply that there is more, and significantly richer communication data for researchers to work with. Most obviously this refers to the familiar assortment of streaming and interconnected information that is readily available on the Internet in the form of information ranging from text, images, videos, communication, and organizational records that can be rendered into network relations. Even beyond this already available data are the technological advancements that are making the collection of streaming behavioral more feasible. One well-known example of this kind of work comes from the “Reality Mining” project at MIT (Eagle & Pentland 2006). As part of this project research participants were given cell phones that continuously recorded their location, the presence of other participants, and all phone calls and text messages. Using these data, researchers could directly model the network of interaction between participants and study its contents in terms of features communicative features like expressions of sentiment in text usage, and voicing qualities. One could easily imagine extensions that would also allow collecting data on biophysical data like physiological change and shifts in body position during interactions.

One potential challenge brought by the availability of such rich data is that of overload. We still must answer the question of how we derive useful findings from the glut of data available to us now. The two primary challenges here have to do with, first, rendering digital materials into usable information, and next, the creation of complex data structures that will allow us to analyze this data in a variety of possible ways. With

computer science, for example, there are already methods for parsing records and texts into spreadsheets of information; Natural Language Processing (NLP) is already quite advanced and capable of rendering texts and voices into an assortment of streaming features tested for meaningful information in other scholarly domains; and data management techniques in computer science (and corporations) have far outpaced the usual simple structures social scientists use to compile their information on individuals.

And alongside these developments in rendering digitized material into usable information have been advances in sheer computing power and novel statistical techniques. In prior decades, dyadic or network modeling was often performed separately from individual models and therefore did not alter or challenge the primacy of the OLS paradigm. Today, the statistical tools and computational power of computers make it feasible to study detailed longitudinal information on the co-evolution of network structures, individual attributes, and interactional processes. From the perspective of network analysis and the sociology of education these data and concomitant methodological watershed offer the same promise. In both areas we hold a view of important social phenomenon as relational and dynamic, but for practical reasons have been long forced to reify social processes into cold and static variables in order to statistically study them. Increasingly, however, we can perform computational ethnography and directly capture the more vibrant, active and ‘warm’ view seen in qualitative research.

Revolutionizing the Study of Trust in Schools

We end with a brief thought experiment about what a shift toward methodological transactionalism might mean for the sociology of education by looking at a more concrete issue, namely trust in schools. First, we would need to collect appropriate data. At the classroom level we might install panoramic video cameras placed in ceilings and small voice recorders on individuals, and then couple this with digitized textual information on student work. Outside of the classroom we could use cell phones readings to trace the daily movements of students and teachers across various social settings, their voicing, and the patterns of their communication with others (e.g., colleagues, peers, principals and parents). At the district and school level we could data mine for various types of transactions, like student course assignments, test scores, grades and extracurricular activities and teacher administrative teams, professional development and parent contacts. We could even acquire digital copies of all policies and curricula and render them into analyzable texts to see how they correspond with voiced texts.

And so imagine now that we had managed to collect the kind of rich digital data described above. What this presents us with is not simply more information about classroom processes (though this is of course part of it), but even more importantly, an opportunity to fundamentally revolutionize our perception of what constitutes interaction and the role that trust plays in it. If we begin to see the classroom not, as we often do now, as a collection of semi-autonomous individuals and their attributes, but instead in terms of an ongoing stream of multi-layered, communicative interactions we can start to see the phenomenon of teaching and learning anew. We can begin to conceptualize the classroom now as an intricate dance in which teachers and students must coordinate their behavioral moves in constant relation to each other, where the pace, rhythm and

temporality of exchanges influences their success and the affective experience of their participants, and knowledge is an emergent feature of shared communication.

Part of what envisioning the classroom as dance allows is a shift away from seeing *trusting* as an mental structure of individuals and instead as a feature of interactions between people. We can start to study trust, in other words, not only in terms of how it facilitates the choice of exchange partners, but also the quality and nature of the transactions themselves. And what is exciting here is that just as dancing involves a complex combination of body control, cognitive scripts, affective feeling and social and partner awareness, so too can we potentially study the trustfulness of classroom transactions on numerous levels. Audio of classroom talk, for example, could be assessed for intensity and pitch features emblematic of emotions associated with the presence or lack of trusting, like say calmness or anger (Jurafsky et al 2009). Pulse and facial temperature readings can be used to gauge excitement and embarrassment, which can in turn be linked to subjective feelings of trust. Eye movement can be used to gauge focus of attention and physical gestures can be recorded to measure levels of gestural synchronicity, each of which could be connected to feelings of trusting. These findings could then be connected to other attitudes or behaviors, to student academic outcomes and records.

The point is that we can imagine numerous ways of directly measuring differences and variances in classroom transactions and the way that they are mediated by trust. Moreover, our current methods for studying trust in schools is a methodological compromise in which, for reasons of practicality, we render our theoretically micro-dynamical construct into something abstract and largely static. It is as if we were

studying real dances by asking people if their feelings of trust toward their partners influenced their performances. Such an approach certainly might yield useful post-hoc information, but it would likely tell us little about actual variance in the nature of the dance itself – for example, do differences in levels of engrossment exist, or are bodies positioned differently depending on their levels of trust? And just as importantly, what precisely does a person do while dancing to make their partner trust them more? The point here is that, just as with classrooms, our real concern is with the activity that people are collectively engaged in, and trust only in so far as it helps us understand the nature of experience in that activity. The incredible new vistas opening up to us through new ways of collecting and analyzing streaming behavioral data suggest that methodological transactionalism affords a revolutionizing means to capture the dance of social life more faithfully than our standard models.

REFERENCES

- Abbott, Andrew. 1988. "Transcending General Linear Reality." *Sociological Theory* 6, 2:169-186
- Almack, John C. 1922. The influence of intelligence on the selection of associates. *School and Society* 16:529-530.
- Ayalon, Hanna, and Abraham Yogeve. 2005. "Field of Study and Students' Stratification in an Expanded System of Higher Education: The Case of Israel." *European Sociological Review* 21: 227-41.
- Baerveldt, Chris, Beate Völker, and Ronan Van Rossem. 2008. Revisiting selection and influence: An inquiry into the friendship networks of high school students and their association with delinquency 1. *Canadian Journal of Criminology and Criminal Justice* 50 (5): 559-587.
- Barabasi, Albert-Laszlo. 2003. *Linked: How Everything Is Connected to Everything Else and What It Means*. Plume.
- Baron, James N. 1984. "Organizational Perspectives on Stratification." *Annual Review of Sociology* 10:37-69.
- Bergesen, A. 2007. "Exploring the Impact of Social Class on Adjustment to College: Anna's Story." *International Journal of Qualitative Studies in Education* 20:99-119.
- Bidwell, Charles E. and Jeffrey Y. Yasumoto. 1999. The collegial focus: Teaching fields, collegial relationships, and instructional practice in American high schools. *Sociology of Education* 72 (4): 234-256.
- Blau, Peter. 1994. *Structural Contexts of Opportunities*. Chicago: University of Chicago Press.
- Blau, Peter, and Otis D. Duncan. 1967. *The American Occupational Structure*. New York: John Wiley.
- Bourdieu, Pierre and Jean-Claude Passeron. 1977. *Reproduction in Education, Society and Culture*. Translated by R. Nice. London: Sage Publications.
- Boyack, Kevin W., Börner, Katy and Klavans, Richard. (2009) Mapping the Structure and Evolution of Chemistry Research. *Scientometrics*. 79(1), pp. 45-60.
- Breiger, Ronald L. 1974. "The Duality of Persons and Groups." *Social Forces* 53: 181-190.
- Brint, Steven. 2009. "The 'Collective Mind' at Work: A Decade in the Life of U.S. Sociology of Education." *Sociology of Education Newsletter* 12: 7-15.
- Bryk, Anthony S. and Barbara L. Schneider. 2002. *Trust in Schools: A Core Resource for Improvement*. New York: Russell Sage Foundation .
- Burk, William J.,, Christian E.G. Steglich, and Tom A.B. Snijders. 2007. Beyond dyadic interdependence: Actor-Oriented models for co-evolving social networks and individual behaviors. *International Journal of Behavioral Development* 31 (4): 397. Web.
- Burt, Ronald S. 1980. "Models of Network Structure." *Annual Review of Sociology* 6: 79-141.
- Carbonaro, William. 1998. "A Little Help from My Parent's Friends: Intergenerational Closure and Effects on Educational Outcomes." *Sociology of Education* 71:295-313.

- Christakis, Nicholas A. and James H. Fowler. 2009. *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives*. Little, Brown and Company.
- Clogg, Clifford C. 1992. The impact of sociological methodology on statistical methodology. *Statistical Science* 183-196.
- Coburn, Cynthia E and Jennifer L Russell. 2008. District policy and teachers' social networks. *Educational Evaluation and Policy Analysis* 30 (3): 203.
- Coleman, James S. 1961. *Adolescent Society: The Social Life of the Teenager and its Impact on Education*. Greenwood Press.
- Coleman, James S. 1994. "A Vision for Sociology." *Society* 32, 1:29-34.
- Converse, Jean M. 1987. *Survey Research in the United States: Roots and Emergence 1890-1960*. University of California Press.
- Daly, Alan J., and Kara S. Finnigan. 2010. A Bridge Between Worlds: Understanding Network Structure to Understand Change Strategy. *Journal of Educational Change* 11: 111-38.
- Davies, Scott and Neil Guppy. 1997. "Fields of Study, College Selectivity, and Student Inequalities in Higher Education." *Social Forces* 75:1417-1438.
- Diani, Mario. 1995. *Green Networks: A Structural Analysis of the Italian Environmental Movement*. Edinburgh: Edinburgh University Press.
- Durkheim, Emile. 1973. *Moral Education*. New York: Free Press.
- Eagle, Nathan and Alex Pentland. 2006. Reality mining: Sensing complex social systems. *Personal and Ubiquitous Computing* 10 (4): 255-268.
- Emirbayer, Mustafa and Jeff Goodwin. 1994. "Network Analysis, Culture, and the Problem of Agency." *American Journal of Sociology* 99: 1411-1154.
- Emirbayer, Mustafa. 1997. "Manifesto for a Relational Sociology." *American Journal of Sociology*, Vol. 103, No. 2: 281-317.
- Fernandez, Roberto, and Nancy Weinberg. 1997. "Sifting and Sorting: Personal Contacts and Hiring in a Retail Bank." *American Sociological Review* 62:883-902.
- Frank, Kenneth A, Chandra Muller, Kathryn S Schiller, Catherine Riegler-Crumb, Anna S Mueller, Robert Crosnoe, and Jennifer Pearson. 2008. The social dynamics of mathematics coursetaking in high school. *American Journal of Sociology* 113 (6): 1645-96.
- Frank, Kenneth A, Yong Zhao, and Kathryn Borman. 2004. Social capital and the diffusion of innovations within organizations: The case of computer technology in schools. *Sociology of Education* 77 (2): 148.
- Frank, Ove and David Strauss. 1986. Markov graphs. *Journal of the American Statistical Association* 81 (395): 832-842.
- Freeman, Linton C. and A. Kimball Romney. 1987. Words, deeds and social structure: A preliminary study of the reliability of informants. *Human Organization* 46 (4): 330-334.
- Friedkin, Noah. 1998. *A Structural Theory of Social Influence*. New York: Cambridge University Press.
- Friedkin, Noah E. and Michael R. Slater. 1994. School leadership and performance: A social network approach. *Sociology of Education* 67 (2): 139-157.
- Friedkin, Noah and Scott L. Thomas. 1997. "Social Positions in Schooling." *Sociology of Education* 70:239-55.

- Gerber, Theodore, and Sin Yi Cheung. 2008. "Horizontal Stratification in Postsecondary Education: Forms, Explanations, and Implications." *Annual Review of Sociology* 34: 299-318.
- Giddens, Anthony. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Cambridge, UK: Polity Press.
- Granovetter, Mark. 1973. "The Strength of Weak Ties." *The American Journal of Sociology* 78: 1360-80.
- Granovetter, Mark. 1995. *Getting a Job: A Study in Contacts and Careers*. Chicago: University of Chicago Press.
- Hamre, Bridget K., Robert C. Pianta, Andrew J. Mashburn, and Jason T. Downer. 2007. Building a science of classrooms: Application of the CLASS framework in over 4,000 US early childhood and elementary classrooms. *Foundation for Childhood Development*. 30:2008.
- Hansen, Morten T. 1999. "The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge Across Organization Subunits." *Administrative Science Quarterly* 44:82-111.
- Hargens, Lowell L. 2000. "Using the literature: Reference networks, reference contexts, and the social structure of scholarship." *American Sociological Review* 65:846-865.
- Haynie, Dana L. 2002. Friendship networks and delinquency: The relative nature of peer delinquency. *Journal of Quantitative Criminology* 18 (2): 99-134.
- Horvat, Erin McNamara, Elliot B. Weininger, and Annette Lareau. 2003. "From Social Ties to Social Capital: Class Differences in the Relations between Schools and Parent Networks." *American Educational Research Journal* 40: 319-51.
- Hoy, Wayne K., C. John Tarter, and Anita W Hoy. 2006. Academic optimism of schools: A force for student achievement. *American Educational Research Journal* 43 (3): 425.
- Hunter, David R., Mark S. Handcock, Carter T. Butts, Steven M. Goodreau, and Martina Morris. 2008. Ergm: A package to fit, simulate and diagnose exponential-family models for networks. *Journal of Statistical Software* 24 (3).
- Igo, Sarah. 2006. *The Averaged American: Surveys, Citizens, and the Making of a Mass Public*. Harvard University Press.
- Jackson, Mathew. 2008. *Social and Economic Networks*. Princeton University Press.
- Jurafsky, Dan, Rajesh Ranganath, and Daniel McFarland. 2009. "Extracting Social Meaning: Identifying Interactional Style in Spoken Conversation." *Proceedings of NAACL HLT 2009*.
- Kerckhoff, Alan C. 1995. "Institutional Arrangements and Stratification Processes in Industrial Societies." *Annual Review of Sociology* 15:323-347.
- Kowalski, Robin M and Susan P Limber. 2007. Electronic bullying among middle school students. *Journal of Adolescent Health* 41 (6): 22.
- Latour, Bruno. 2005. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford University Press.
- Law, John and John Hassard (eds). 1999. *Actor Network Theory and After*. Blackwell Publishing.
- Lazer, David, A. Sandy Pentland, Lada Adamic, Sinan Aral, Albert Laszlo Barabasi, Devan Brewer, Nicholas Christakis, et al. 2009. "Life in the network: The coming

- age of computational social science.” *Science* 323 (5915): 721-2323.
- Lin, Nan. 2001. *Social Capital: A Theory of Social Structure and Action*. Cambridge University Press.
- Louis, Karen S. 2007. “Trust and improvement in schools.” *Journal of Educational Change* 8 (1): 1-24.
- Leskovec, J., L. Backstrom, J. Kleinberg. 2009. “Meme-tracking and the Dynamics of the News Cycle.” *ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD)*, 2009.
- Lubbers, Miranda J. 2003. “Group composition and network structure in school classes: A multilevel application of the p* model.” *Social Networks* 25 (4): 309-332.
- Lucas, Samuel R. 2001. “Effectively Maintained Inequality: Education Transitions, Track Mobility, and Social Background Effects.” *American Journal of Sociology* 106: 1642-90.
- Manski, Charles. 1995. *Identification Problems in the Social Sciences*. Cambridge, MA: Harvard University Press.
- Martin, John Levi. 2003. “What is Field Theory?” *American Journal of Sociology* 109: 1-49.
- Massy, Douglas, and Nancy A. Denton. 1993. *American Apartheid: Segregation and the Making of the Underclass*. Cambridge, MA: Harvard University Press.
- McFarland, Daniel A. 2001. “Student resistance: How the formal and informal organization of classrooms facilitate everyday forms of student defiance.” *American Journal of Sociology* 107 (3): 612-78.
- McFarland, Daniel A. 2006. “Curricular Flows: Trajectories, Turning Points, and Assignment Criteria in High School Math Careers.” *Sociology of Education* 79 (3): 177-205.
- McFarland, Daniel A. and Simon Rodan. 2009. “Organization by Design: Supply- and Demand-Side Models of Math Careers.” *Sociology of Education* 82 (4): 315-343.
- McFarland, Daniel and Heili Pals. 2005. “Motives and contexts of identity change: A case for network effects.” *Social Psychology Quarterly* 68 (4): 289.
- Moody, James. 2004. “The Structure of a Social Science Collaboration Network: Disciplinary Cohesion from 1963 to 1999.” *American Sociological Review* 69: 213-38.
- Morgan, Stephen L and Aage B Sørensen. 1999. “Parental Networks, Social Closure, and Mathematics Learning: A test of Coleman's Social Capital Explanation of School Effects.” *American Sociological Review* 64 (5): 661-681.
- Morris, Martina. 2003. “Local rules and global properties: Modeling the emergence of network structure.” *In Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers*. Ed. Ron L Brieger, Kathleen M Carley, and Philippa Pattison.
- Newman, M.E.J. 2001. “The Structure of Scientific Collaboration Networks.” *Proceedings of the National Academy of Sciences* 98: 404-9.
- Pearson, Michael, Christian Steglich, and Tom Snijders. 2006. “Homophily and assimilation among sport-active adolescent substance users.” *Connections* 27 (1): 51-67.
- Penuel, William, Margaret Riel, Ann Krause, and Kenneth Frank. 2009. Analyzing teachers' professional interactions in a school as social capital: A social network approach. *The Teachers College Record* 111 (1): 124-163.

- Pittinsky, Matthew and Brian V Carolan. 2008. Behavioral versus cognitive classroom friendship networks. *Social Psychology of Education* 11 (2): 133-147.
- Platt, Jennifer. 1996. *A History of Sociological Research Methods in America, 1920-1960*. Cambridge University Press.
- Raudenbush, Stephen and Robert J. Sampson. 1999. "Ecometrics': Toward A Science of Assessing Ecological Settings, with Application to the Systematic Social Observation of Neighborhoods.'" *Sociological Methodology* 29:1-41.
- Rawlings, Craig M., and Michael D. Bourgeois. 2004. "The Complexity of Institutional Niches: Credentials and Organizational Differentiation in a Field of American Higher Education." *Poetics* 32: 411-37.
- Rawlings, Craig M., Daniel McFarland, Linus Dahlander, Dan Wang. 2010. "Funnels and Filters: When Networks Channel Intra-Organizational Knowledge Flows." Working Paper, Stanford University.
- Reagans, Ray E., Ezra W. Zuckerman, and Bill McEvily. 2004. "How to Make the Team: Social Networks vs. Demography as Criteria for Designing Effective Projects in a Contract R&D Firm." *Administrative Science Quarterly* 49: 101-133.
- Robins, Gary, Philippa Pattison, and Josie Woolcock. 2005. Small and other worlds: Global network structures from local processes. *Ajs* 110 (4): 894-936.
- Robins, G., Snijders, T. Wang, P., Handcock, M. and Pattison, P. 2007. "Recent developments in exponential random graph (p^*) models for social networks." *Social Networks* 29: 192-215.
- Sandefur, Rebecca and Edward Laumann. 1998. "A Paradigm for Social Capital." *Rationality and Society* 10,4:481-501.
- Singh, Jasjit. 2005. "Collaborative Networks as Determinants of Knowledge Diffusion Patterns." *Management Science* 51: 756-70.
- Small, Mario L. 2009. *Unanticipated Gains: Origins of Network Inequality in Daily Life*. New York: Oxford University Press.
- Snijders, T., Pattison, P.E., Robins, G.L. and Handcock, M.S. 2006. "New specifications for exponential random graph models.'" *Sociological Methodology* 2006, pp. 99-153.
- Snijders, Tom A. B.,, Gerhard G. Van de Bunt, and Christian E. G. Steglich. 2010. Introduction to stochastic actor-based models for network dynamics. *Social Networks* 32 (1): 44-60.
- Sorokin, Pitirim. 1959 [1927]. *Social and Cultural Mobility*. New York: Free Press.
- Spillane, James P. and Charles L. Thompson. 1997. Reconstructing conceptions of local capacity: The local education agency's capacity for ambitious instructional reform. *Educational Evaluation and Policy Analysis* 19 (2): 185-203.
- Steglich, Christian, Tom A. B. Snijders, and Patrick West. 2006. Applying SIENA. *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences* 2 (1): 48-56.
- Stevens, Mitchell. 2008. "Culture and Education." *Annals of the American Academy of Political and Social Sciences* 619: 97-113.
- Stevens, Mitchell, Elizabeth Armstrong, and Richard Arum. 2008. "Sieve, Incubator, Temple, Hub: Empirical and Theoretical Advances in the Sociology of Higher Education." *Annual Review of Sociology* 34: 127-51.
- Stuber, Jenny. 2006. "Talk of Class and Discursive Repertoires of White Working and

- Upper-Middle Class College Students.” *Journal of Contemporary Ethnography* 35: 285-318.
- Tarrow, Sidney. 1994. *Power in Movement: Social Movements, Collective Action and Politics (2nd Edition)*. New York/Cambridge: Cambridge University Press.
- Van de Bunt, Gerhard G, Rafael P M Wittek, and Maurits C de Klepper. 2005. The evolution of intra-organizational trust networks: The case of a german paper factory: An empirical test of six trust mechanisms. *International Sociology* 20 (3): 339.
- Van Rossem, Ronan and Marjolijn M. Vermande. 2004. Classroom roles and school adjustment. *Social Psychology Quarterly* 67 (4): 396.
- Vermeij, Lotte, Marijtje A. J. van Duijn, and Chris Baerveldt. 2009. Ethnic segregation in context: Social discrimination among native DutchDutch pupils and their ethnic minority classmates. *Social Networks*.
- Wasserman, S., and Robins, G.L. 2005. An Introduction to Random Graphs, Dependence Graphs, and p^* . In Peter Carrington, John Scott, and Stanley Wasserman (Eds.), *Models and Methods in Social Network Analysis*. Cambridge University Press.
- Wasserman, Stanley and Philippa Pattison. 1996. Logit models and logistic regressions for social networks: I. An introduction to markov graphs andp. *Psychometrika* 61 (3): 401-425.
- Wasserman, Stanley, John Scott, and Peter J. Carrington. 2005. Introduction. In *In Models and Methods in Social Network Analysis*. Ed. Peter J Carrington, John Scott, and Stanley Wasserman. Cambridge Univ Pr.
- Watts, Duncan J. 2004. *Six Degrees: The Science of a Connected Age*. W. W. Norton & Company.
- Weber, Max. 1968. *Economy and Society*. Berkeley, CA: University of California Press.
- Wellman, Barry and S.D. Berkowitz (Eds.). 1988. “Structural Analysis: From Method and Metaphor to Theory and Substance.” Chapter 2 (pp. 19-61) in *Social Structures: A Network Approach*. Cambridge: Cambridge University Press.
- Wellman, Beth. 1926. The school child's choice of companions. *The Journal of Educational Research* 14 (2): 126-132.
- Wells, Gordon. 1993. Reevaluating the IRF sequence: A proposal for the articulation of theories of activity and discourse for the analysis of teaching and learning in the classroom. *Linguistics and Education* 5 (1): 1-37.
- White, Harrison C., Scott A. Boorman, and Ronald L. Breiger. 1976. Social structure from multiple networks. I. Blockmodels of roles and positions. *American Journal of Sociology* 81 (4): 730-780.
- Wiley, Susan D. 2001. “Contextual Effects on Student Achievement: School Leadership and Professional Community.” *Journal of Educational Change* 2: 1-33.
- Willis, Paul. 1977. *Learning to Labor: How Working Class Kids Get Working Class Jobs*. New York: Columbia University Press.
- Wyatt, Danny, Tanzeem Choudhury, Jeff Bilmes, and James A.Kitts. 2008. "Towards the Automated Social Analysis of Situated Speech Data" *Proceedings of the International Conference on Ubiquitous Computing*, September 2008.
-