NETWORKS AND PERFORMANCE IN PUBLIC ORGANIZATIONS: THEORY, MODELS, AND MEASUREMENT

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This study explores the antecedents of intra-organizational networks and the consequences of network structure on the attitudes and performance of public school teachers in twenty-one schools. On the antecedent side, the relationships among teacher social networks, teacher attributes, and interpersonal perceptions were assessed. The results, based on a meta-analysis of each school's statistical model, indicate that teacher interpersonal perceptions along eleven salient personality traits were important predictors of network formation. The results point toward the significance of psychological and cognitive factors in network formation that are often overlooked in structural analysis.

Network autocorrelation models were used to assess how the attitudes and beliefs of a teacher's peers in the advice and friendship networks influence the teacher's own attitudes and beliefs. While the total quantity of network activity was shown to have little effect on measures of self-efficacy and organizational commitment, the quality of one's social connections was strongly predictive. For student engagement efficacy, classroom management efficacy, instructional strategy efficacy, and organizational commitment, teachers were positively influenced by the efficacy and commitment beliefs of their peers in the advice network. Therefore, it was not simply the number of connections a teacher formed in a network that was important but rather the attitudes and beliefs held by those social connections. Analysis revealed that friendship ties, which are capable of transmitting negative dialogue and sentiment, can potentially have a detrimental influence on efficacy and commitment when those ties do not coexist with advice ties.

Value-added measures of teacher performance were built to measure the gain in student test scores that could be attributed to a particular teacher. Statistical models showed that two variables were significant and positive predictors of both math and reading value-added: the

amount of reflective dialogue in the school and the organizational commitment of a teacher's peers. The latter variable suggests that teacher performance is driven by social connections to strongly committed coworkers rather than one's own sense of organizational commitment. Overall, the study provides strong evidence of the importance of social connections within schools and suggests that current policy aimed at creating greater levels of competition among teachers in schools may be counterproductive as competition can hinder collaboration.

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1.0 INTRODUCTION

In the early 1900's, the theory of rationality dominated the theoretical base in public administration and organization theory. Predicated on the belief that humans were rational self-maximizers, scholars at this time developed incentive systems based around monetary rewards for individual performance (Taylor, 1911). Taylor sought to find, through scientific investigation, the single best means of extracting optimal performance from workers. This view neglected the social structure of work except for the formally and hierarchically structured organizational chart. It was not until the research carried out at the Hawthorne plant of the Western Electric Company in Chicago that the role and importance of informal structures and non-monetary incentives were realized (Roethlisberger and Dickson, 1939).

Around this time, Chester Barnard moved away from emphasizing the formal organizational structure and traditional management principals, arguing that organizations were social environments (Barnard, 1938). Barnard believed that organizations were not simply hierarchies of authority, but rather cooperative social systems. Douglas M. McGregor broke away from a conventional view of management and human motivation in his development of a new theory of management which he termed "Theory Y" (McGregor, 1957). McGregor was interested in the human side of an organization, one that attended to the social and self-fulfillment needs of its members. He argued that cohesive work groups are more effective than

isolated individuals and that managers who engaged in open communication with subordinates would foster greater levels of trust and creativity.

What early organizational scholars like Barnard, McGregor, and others were claiming is that social relations in organizations matter. What was unknown however, and remains puzzling, were the processes by which certain structures of relations emerged and ultimately produced beneficial outcomes. Methodologies, like network analysis, for studying informal structure and linking variation in structure to social phenomena are critical for our understanding of organizations as social systems. Social network analysis has a long history (Freeman, 2004), however, most scholars tie the pursuit of structural analysis to Jacob Moreno's (1934) work in sociometry. Some of the earliest and most influential work on network structure was conducted in the 1950s by the Small Group Network Laboratory at MIT. This group designed experimental studies to assess how network structure impacted group performance on simple tasks (Bavelas, 1950; Leavitt, 1951). The results of the work solidified the importance of centrality in networks and clearly revealed that the structure of communication patterns among individuals in a group strongly influenced performance.

Over the next 60 years, network research in organizations expanded to investigate the effects of network structure on a range of outcomes. The domain of network research includes work on attitude similarity and homophily (Galaskiewicz and Burt, 1991), job search (Granovetter, 1973, 1983) , employee turnover (Krackhardt and Porter, 1985; Krackhardt and Porter, 1986), leadership (Pastor et al., 2002), team performance (Tsai, 2001), commitment and job satisfaction (Morrison, 2002; Roberts and O'Reilly, 1979), and profitability (Krackhardt and Hanson, 1993).

1.1 LIMITATIONS IN ORGANIZATIONAL NETWORK RESEARCH

Despite the exponential growth in the application of social network analysis to the study of organizational phenomena (Borgatti and Foster, 2003), the field faces several limitations. These limitations have both empirical and theoretical origins. The primary empirical issues are: the general lack of research on network antecedents, the neglect of cognitive processes in structural analysis, the lack of cross-network research, and the difficulty in isolating the causal effect of network structure. The primary theoretical issue concerns the measurement and application of the sociological concept of social capital to the study of networks.

1.1.1 Lack of research on network antecedents

Networks can be viewed as both an outcome to be explained and as a predictor of other phenomena – both an explanandum and explanans. This trait is in no way unique to the analysis of networks. For example, in education, the number of years of schooling an individual obtains is frequently a dependent variable but is often used as a predictor of other phenomena, say, an individual's average income. In the field of development, the human development index is also seen as an outcome and a predictor. The fact that so many variables in the social sciences are useful and logical as an explanandum and explanans is one of the difficulties in attempting to conduct causal research (see Section 1.1.5 below).

When networks are seen as predictors of outcomes of interest, one seeks to discover the consequences and implications of certain network structures. When networks are themselves the outcome of interest, one seeks to discover the process by which networks formed. In other words, what are the impacts of particular network structures and what led the network to cohere

in such a particular way? To date, empirical research on the antecedents of networks is currently limited as the bulk of research has focused on the consequences of networks (Borgatti and Foster, 2003). This claim is reiterated by Brass et al. (2004) in their review of the literature on networks and organizations claiming that "more work is needed on network antecedents"(p. 800).

A primary reason why research has been predominantly engaged with the consequences of networks was the need to establish, initially, the importance of network variables to the organizational context under study. Once network variables have been legitimized, a logical next step is to investigate the processes leading individuals to interact by providing statistical inferences regarding network determinants. Ultimately, if we want to better understand networks, especially informal network formation in organizational settings, we need to understand the micro processes of how ties are formed. Simply stated, we need to know why actor A and actor B choose to generate a voluntary relationship with one another. From an applied or policy perspective, understanding the antecedents of networks in organizations is just as critical as understanding their consequences if managers hope to positively influence the informal structure of the organization.

1.1.2 Neglect of cognitive processes

Network ties may be influenced to some extent by formal structure, but who an actor seeks out for advice or friendship in the organization is a personal decision that has implications not only for that actor and his or her personal network, but also for the overall structure and function of the organizational network. Previous research on the antecedents of network formation has tended to consider two dynamics - structural and demographic. The structural effects most

commonly investigated in networks are reciprocity and transitivity. Demographic based effects, grounded in the fundamental notion of homophily, capture the preference for similar actors to interact with one another (Byrne, 1971). In addition to these two effects, there is a powerful psychological component of network formation based on interpersonal perceptions (Kenny, 1994). This psychological aspect of social networks has generally been ignored by network researchers (Kadushin, 2012, p. 56) despite the fact that interpersonal perceptions are the cognitive drivers of social behavior (Kenny, 1994). Hence, there is a missing variable problem affecting most antecedent network research. In order to build more rigorous models of network formation, one needs to analyze not only the structural and demographic factors involved in tie formation, but also the cognitive component.

Kilduff and Tsai (2003, p. 85) claim that "[g]iven the persistence of the anti-categorical imperative among sociological researchers on the one hand (e.g., Mark, 1998) and the neglect of networks by those studying social relations from a psychological perspective on the other hand (e.g., Agnew et al., 2001), there is a pressing need for non-dogmatic research that explores issues concerning how individual differences in cognition and personality relate to the origins and formations of social networks." Underscoring this need to link structural and psychological perspectives in the study of organizational networks, the Organization Science Journal in early 2012 placed a call for papers to be included in a special issue on the psychology of organizational networks. The call for papers stated:

> "In its purest form, the structuralist perspective that underlies network studies of organizations de-emphasizes (Wellman and Berkowitz, 1988) or denies altogether (Mayhew, 1980) the importance of social actors' individual characteristics and psychological processes in favour of explanations of organizational phenomena that focus on the patterns of relationships linking actors to one another, and the topological and positional configurations that drive

> actors' behaviour. Yet, as social networks, the structural patterns of relationships that emerge in organizations unavoidably implicate human psychology. Unlike neural, molecular, and other networks in the physical world, organizational networks connect feeling and thinking human beings."

1.1.3 Assessing network outcomes and cross-network research

Because networks are the veins of the organization through which information and resources flow (Borgatti and Foster, 2003; Raider and Krackhardt, 2001), they are a key component in how individuals and organizations adapt and improve. However, measuring the extent to which individuals improve their performance within the context of an organization has been difficult to assess. In instances where individual outcomes are emphasized (e.g., Burt, 1992), these outcomes are not direct measures of performance. As Mehra et. al (2001, p. 123) note, "[p]revious work has focused on the effects of structural position on outcome variables such as power and promotions, but has offered little conclusive evidence concerning performance in organizations."

A major reason for the lack of evidence on performance is the challenge of attempting to compare different actors' performance in an organization as each individual tends to have his or her own set of unique tasks and objectives. Finding valid and objective measures of individual performance in collective endeavors is an ongoing challenge. Additionally, due to the cost and time associated with network data collection, the role of organizational level variables in moderating the relationship between individual networks and outcomes is not accounted for. Issues arise when research is conducted at one network level or one system level while ignoring

potentially important cross-level interactions and moderator effects that may be present in organizational structures that are inherently multilevel (Wellman and Frank, 2001).[1]

The majority of network studies exclusively analyze exchange dyads in organizations. By limiting attention to dyads and ignoring the larger context, one cannot determine how the overall structure influences the presence or absence of ties (Contractor et al., 2006). Furthermore, determining the moderating role that the overall network structure plays on the relationship between individual network position and individual network performance is an important, but generally missing, piece in organizational network research.

In an attempt to gain statistical traction at the organizational level, some researchers have chosen to take a large-n "quasi-network" approach to allow for statistical hypotheses testing. Meier and O'Toole (2005) were interested in the performance of superintendents in over 500 school districts. The superintendents were asked how frequently they interacted with five key actors involved in the school system: school board members, local business leaders, state legislators, other superintendents, and the state education agency. Their study, unlike standard network research, only surveyed one member in each of the 500 networks. The superintendent simply provided information on frequency of contact with generic groups or titles of individuals. Data on the ties to and from specific individual actors was not obtained and thus traditional network analysis could not be performed on the resulting data. Meier and O'Toole acknowledge the limitations of such a large-*n* approach to capture the intricacies and complexities of human networks, but also the limitations of small-*n* studies to validate hypotheses that require numerous cases and a range of variables. They suggest "there is a tradeoff between intensive knowledge of

[1] It is important to make a distinction between network levels and system levels. Network level refers to the various levels of analysis that one can use to study relationships (ego, dyads, whole network), while system level refers to the hierarchical nesting of sub-systems within larger systems (e.g., individuals nested in work groups nested in organizations).

a particular network and extensive testing for causal patterns across a range of networks. By sacrificing knowledge of the network qua network in favor of an appropriate albeit limited measure of managers' networking behavior in interdependent settings, researchers can gain some leverage on otherwise intractable but important research questions" (p. 526).

Both the lack of adequate measures of individual performance and lack of cross-network research allowing for the investigation of the interaction between individual and organizational variables are significant issues. Research wishing to address these topics needs to establish objectively defined measures of individual success and gather data in a number of comparable organizational settings.

1.1.4 Measurement and theory of social capital

The primary theoretical mechanism used to link social networks to positive organizational and individual outcomes is social capital (Burt, 2000). Social capital captures the idea of a social asset that accrues to an individual or group through connections to others who hold information and/or resources (Bourdieu, 1986; Lin, 2001A, 2001B). Given this constitutive definition, there is a clear link between networks and social capital. The problem, however, is the manner in which social capital has been operationalized and how different groups of researchers have explained the processes by which the concept functions. As Lin (2001A, 2001B) discusses, there are three controversies hindering the conceptual development of social capital.

The first controversy concerns the level at which return or profit is conceived. In other words, whether benefits from resources embedded in social structures accrue to individuals (Burt, 1992) or to groups (Coleman, 1988; Putnam, 2000). Whether a collective benefit or an individual one, the mechanism remains the same – the ties and linkages between actors in a

group are responsible for the creation of social capital. While many scholars will agree that social capital can operate on both an individual and collective level, as noted above, there has been little work attempting to determine the moderating role that the group network plays on the individual's benefit.

A second controversy regarding social capital is the debate over whether closed or open networks lead to social capital. Some scholars (Bourdieu, 1986; Coleman, 1990; Putnam, 1995; Putnam et al., 1993) view dense networks as necessary conditions for the generation of social capital, arguing that close ties within a group maintain and enhance trust and norms. Other research has stressed the importance of bridges in networks in facilitating information flow and opportunity (Burt, 1992; Granovetter, 1973). These competing operationalizations muddle our conception of social capital.

A third controversy is the implicit tautology of the concept itself. Coleman claimed that "social capital is defined by its function" (1990, p. 302). As Lin points out this "functional view may be a tautology: social capital is identified when and if it works…Thus, the causal factor is defined by the effect" (Lin, 2001B, p. 11). This tautology was also criticized by Portes (1998) in his discussion of Putnam's 1993 work. Portes claims that Putnam's argument is simply, "If your town is 'civic', it does civic things; if it is 'uncivic' it does not" (1998, p. 20). The mixing of cause and effect limits the conceptual development of social capital and its application to the study of organizational networks.

1.1.5 Causality and networks

A final limitation facing organizational network research is the thorny problem of causality. Take for instance Burt's work on structural holes. Burt argues that individuals who are

positioned between unconnected others (what he terms structural holes) reap particular benefits. In Burt's terms, "[c]ausation resides in the intersection of relations" (1992, p. 192). However, Burt's is not a causal argument. Even though he is able to show that there is a strong correlation between the structural holes filled by an individual and an outcome of interest, the problem of latent variables is unaddressed. A latent variable that leads an individual to a particular structurally advantageous position in a network may be the same variable that leads him or her to more successful outcomes. Without being able to differentiate between the impact of network position and the impact of a latent variable that is correlated with both network position and the outcome, one is unable to judge causality. In order to assess the causal impact of networks, one needs to understand and identify both the processes that lead networks to form and the processes that result in beneficial outcomes for individuals occupying advantageous positions in the network.

Recent criticism of Christakis and Fowler's (2009) book *Connected* and associated papers (Christakis and Fowler, 2010) with regard to the methodology they employed to estimate causal effects has propelled the issue of causality and networks into popular media (Johns, 2010). Two of the major academic criticisms laid out by Lyons (2011) and Cohen-Cole and Fletcher (2008) claim that the statistical methods used by Christakis and Fowler are unable to adequately measure network effects. To prove their claim, Cohen-Cole and Fletcher (2008), using the same data and models as Christakis and Fowler, successfully found network effects on health outcomes that cannot plausibly be connected to social networks, such as acne, height, and headaches. Shalizi and Thomas (2010) mathematically demonstrated that one cannot distinguish between the processes of homophily and network effects (also referred to as social influence), as they relate to behavioral outcomes or responses. Sophisticated actor-based models are being

developed to tease apart network effects from selection effects in dynamic behavioral networks (Steglich et al., 2010).

Such models for longitudinal network data do not completely protect the researcher from the latent variable problem related to individual personality and interpersonal perception. One can find network effects that are nothing more than an artifact of some unmeasured personality variable that drove one's network position. In order to get a hold of causality in networks, better data is often needed. Nonetheless, no amount of data and rigorous modeling will ever be able to assure the researcher that his or her model is correctly specified, and so better theory is needed as well.

1.2 THEORETICAL FRAMEWORK AND RESEARCH OBJECTIVES

While there are wide ranging views on whether or not network analysis can be viewed as both a method of analysis and a theoretical perspective, most scholars believe that the social network approach constitutes a theory. Degenne and Forse (1999) claim that the social network approach is a theory of social structures. In their review of the theoretical literature, Kilduff and Tsai (2003) categorized the theoretical foundations of network analysis into three areas:

1. *Imported theories* – those that were borrowed from other disciplines. For example, from mathematics like connectedness, graph hierarchy, graph efficiency, and least upper boundedness or from social psychology like balance theory, cliques, Simmellian ties, Bott's hypothesis, and homophily.

2. *Indigenous theories* – those that were home-grown by network researchers such as heterophily theory, strength of weak ties, and structural holes.

3. *Exportation theories* – those using existing organization theories and critiquing them from an social network analysis perspective. For example, contingency theory and resource dependency theory.

What underpins these different categories and ultimately creates a unique theory of structure is the "network perspective". The network perspective argues that the performance of actors, individually and collectively, depends not only on the distribution of attributes and talents but also on the distribution of relationships (Brass, 1995). Research utilizing a network perspective is seen as an improvement upon traditional economic theory or rationality because it "escapes the debilitating social science practice of using player attributes for explanation" (Burt 1992, p. 4). The network perspective therefore guides researchers to emphasize the role of structure in understanding important social phenomena.

In work related to the network perspective, Hutchins (1995) acknowledges the interdependence between individual cognition, social structure, and system goals, through his theory of distributed cognition. In Hutchins view, no single individual within any complex organizational setting possesses the knowledge or skill needed to achieve successful system level performance. Because cognition is shared across multiple actors, proper action necessitates collaboration and the sharing of knowledge to improve decision making and performance. Experimental research on structure and performance revealed that individuals with the same resources and skill sets can have wide discrepancies in performance based on the relationships that exist among the actors (Bavelas, 1950; Leavitt, 1951).

Hutchins (1995) provides a framework to analyze the performance of an organization as it relates to the microstructure and distribution of intelligence and tasks across a set of individuals and groups. This framework provides an approach to understand the intersection between cognition and the social organization of work. We learn from Hutchins that there are

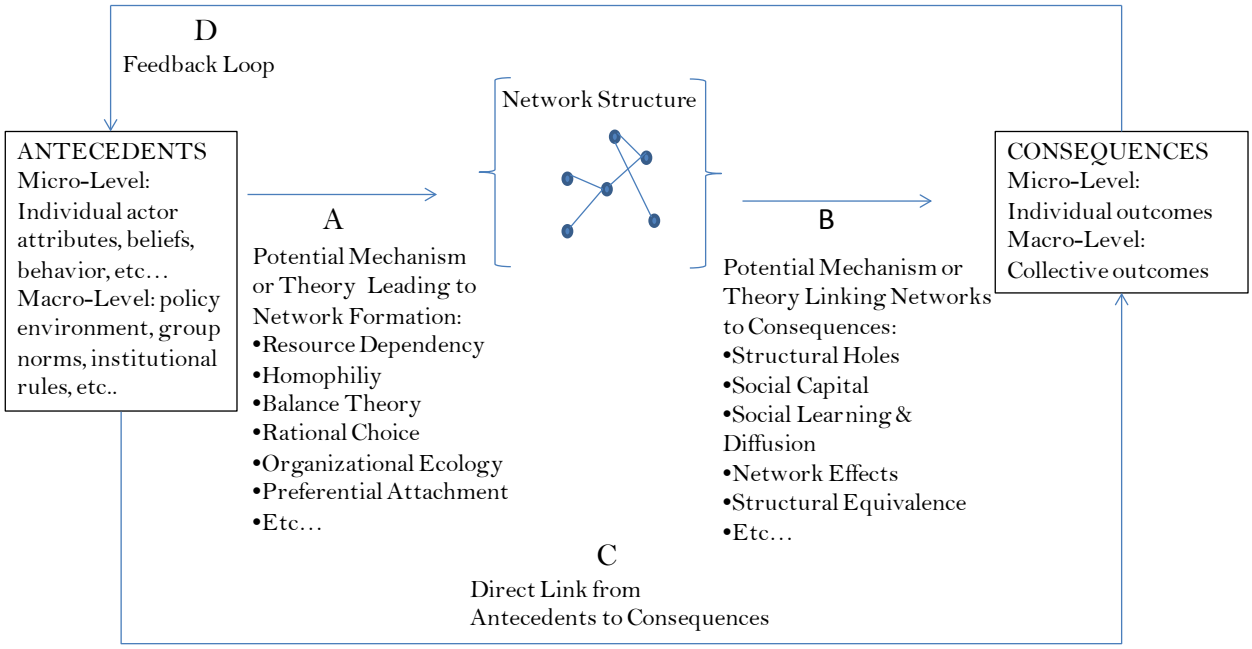
severe limitations on the human capacity to design procedures capable of effectively handling various events. No institution could possibly plan for the entire range of large scale environmental shocks or the uniquely complex situations that arise on a daily basis. As Herbert Simon argues, there are bounds to our rationality (Simon, 1996).

The ideas and concepts captured in distributed cognition and network theory are critical for understanding the social structure of organizations and the ways in which knowledge, information and resources are shared. Network theory and methods provide suitable tools to analyze how the structure of relations in organizations impact performance on an individual and collective level.

1.2.1 Network Framework

To more adequately situate the five limitations of organizational network research, this study developed a multilevel network framework. The framework details a system of relationships linking antecedent conditions to multilevel consequences. In general, there are four processes of interest: (A) how antecedent conditions at the individual and group level lead to particular structural arrangements that influence how information and resources flow, (B) how the structure of links between actors leads to variation in both individual and collective outcomes, (C) how antecedent conditions directly impact outcomes, and (D) how feedback and learning loops modify beliefs, attitudes, and group norms.

Figure 1. MultiLevel Framework for Individual, Organizational, and Inter-Organizational Network Antecedents and Consequences



This framework highlights the important theoretical and empirical questions that remain unanswered and widely debated in the literature. If we return to limitation five, concerning the causal connection of network structure, the multilevel framework emphasizes the various processes by which variation in performance outcomes may emerge. For instance, are the attributes that lead an actor to a particular structurally advantageous position (process A) the same attributes that lead the actor to have more successful outcomes (process C)? Or does the network structure have an additional effect (process B) over and above the attributes' direct effect on success? If so, what is the relative weight of each source of influence?

Relying on the multilevel network framework, this study was designed to understand and measure both the antecedents of networks (i.e. how they emerge and form) and the consequences of networks (i.e. how they influence individual and collective performance) in organizations. The investigation of both the antecedents and consequences of network structure on an individual and collective level rarely occurs within a single study. To deal with the complex

issues concerning organizational network research, this study established a unique research design combining personal construct psychology, network antecedent models, and multilevel network consequence models.

1.2.2 Research objectives

The major research objectives, addressing the five limitations in organizational network research, are as follows.

Objective 1. To discover the key personality traits and frames of reference on which organizational actors rely when comparing their coworkers and determining with whom to form a social tie in the organizational environment.

Objective 2. To statistically model how interpersonal perception along the salient personality traits affect relational ties and overall network structure within an organization, while controlling for demographic and structural factors.

Objective 3. To model the effects of individual network position on differences in individual attitudes/beliefs controlling for organization level network variables and cross-level interactions.

Objective 4. To generate a more theoretically grounded and empirically refined assessment of social capital and social networks by analyzing how different types of networks influence different outcomes.

Objective 5. To identify the impact of network structure and social capital on individual performance.

1.2.3 Overview of Chapters

The following chapter provides a rationale for choosing public schools as the organizational setting for research and offers a review of the literature on networks in schools. Chapter 3 provides information on the school district studied, the data collected, and the research design

and methodology employed. Chapter 4 covers the implementation of the role repertory grid methodology used to elicit the relevant cognitive constructs driving network formation (Objective 1). Chapter 5 builds statistical models of network formation for two distinct types of network relations (Objective 2). Chapter 6 utilizes multilevel models to determine the effect of individual network position and whole network measures on individual beliefs and attitudes (Objective 3 and 4). Chapter 6 also builds network autocorrelation models to identify the influence of one's peers on personal beliefs and attitudes (Objective 4). Chapter 7 attempts to understand the impact of network structure on individual performance (Objective 4 and 5). Chapter 8 briefly discusses the thorny issue of causality in networks. Chapter 9 concludes and offers recommendations for education policy.

2.0 PUBLIC SCHOOL SYSTEMS AND ORGANIZATIONAL NETWORKS

From a research design and analysis perspective, two factors were primary determinants in selecting the field study: (i) the ability to compare and measure individual performance within an organization, and (ii) the ability to compare and measure collective performance across organizations. Based on these issues, a public school system was chosen as an ideal field study given the generally agreed upon and objectively defined measure of individual (teacher) and organizational (school) performance: student achievement on standardized tests.

2.1 WHY STUDY NETWORKS IN EDUCATION

While a range of evidence indicates the importance of networks, much of the work of teachers and schools appears to be done in isolation. As Fullan notes, “the cellular organization of schools means that teachers struggle with their problems and anxieties privately, spending most of their time physically apart from their colleagues. Partly because of the physical isolation and partly because of norms of not sharing, observing, and discussing one another’s work, teachers do not develop a common technical culture” (Fullan, 2007, p. 133). This has often been referred to as the “egg crate phenomenon” (Lortie, 2002).

In discussing the structure of school systems that promote the "egg crate phenomenon", Dornbush et al. (1996) note that schools exhibit characteristics of two forms of organizational

structures common in industrialized societies. The first is a professional structure, where teachers are deemed as expert practitioners who are licensed by the state. The other is a bureaucracy, as evidenced by the hierarchical structure present in school districts: school boards, superintendents, principals, and teachers. The combination of these two types of organizational structure generates a system where the teachers tend to operate in isolation (Little, 1990; McLaughlin and Talbert, 2001).

Leithwood (2005) found that the working conditions in most schools are not conducive to sustained teacher innovation. An early study by Goodlad (1984) found a weak or nonexistent link between teachers inside the same school in terms of assistance or collaboration. The large majority of teachers in the Goodlad study said they had never observed another teacher working despite the fact that 75% stated an interest and a desire to do so. Goodlad found very little evidence to suggest an active or ongoing exchange of ideas and practices across schools. In a more recent study, 59% of teachers were characterized as private practice teachers, having little contact within or outside the school concerning their craft, while only 2% of teachers maintained high levels of professional engagement (Riel and Becker, 2000).

Designing policy to enhance teacher collaboration and build teacher networks has the potential to strategically affect how schools and school districts function (Hite et al., 2005). The goal then is to uncover the informal structures and ties within schools along which influence and knowledge is spread and through which work is completed (Deal et al., 2009). The dynamics within a school and a classroom can be seen as the intersection between an individual and the social organization of the teaching task. Hence, Hutchins' framework provides an opportunity to understand the distribution of cognition across the representational states and media of learning, the student, and the teacher. It is precisely this intersection of the learning process that may help

discover why some classrooms and some schools perform so poorly, despite the equivalence of rules, procedures, roles, funding, and interaction with other components like curricula, top level leadership, and technology.

One of the key components of the student learning process is the teacher. Harris and Sass (2009) cite a wide range of recent literature (Aaronson et al., 2007; Hanushek et al., 2005; Kane et al., 2006; Rivkin et al., 2005; Rockoff, 2004) which consistently indicates that teacher productivity is the primary link to student learning. Harris and Sass (2009) also note that teacher productivity varies widely both within and across schools. Despite the importance of teacher performance, there is little understanding of the factors that influence teacher productivity. Recent longitudinal studies have shown weak effects of several commonly measured teacher attributes on student performance (Bryk et al., 2010).

A network perspective and distributed cognition are appropriate lenses as an individual teacher does not perform successfully or unsuccessfully based solely on his or her mental capacity (Resnick, 1991; Spillane et al., 2001). Because of the complexity and rapidly changing environment of the classroom and school, teachers need to be continuous learners (Riel and Becker, 2000). Individuals must interact and communicate with one another to make sense of their operating environment.

In her work on the social organization of schools, Rosenholtz (1991) provides a foundation to support the need for information and resource exchange in schools. Rosenholtz claims that teachers face "uncertainty about how teaching should best be done in ways that enable students to learn and grow" (1991, p. 4). Rosenholtz goes on to say that:

> "Uncertainty arises from an absence of a technical culture, the processes designed to accomplish an organization's goals (Perrow, 1970; Thompson, 1967). For teachers technical knowledge encompasses the skills, procedures, and

> methods that help pupils progress academically. A technical culture is labeled uncertain if the outcomes of work are highly unpredictable; where, because of variability in their students, for example, teachers do not reach automatically for solutions to the myriad of learning problems they confront. Uncertainty means there are few well-established techniques – codified technical knowledge – to help teachers meet students' widely varying needs" (1991, p. 4).

The complexity of an ever changing environment in schools and the uncertainty by which teachers seek to achieve results necessitates the need for open lines of communication and knowledge sharing in the operating environment. Because there is a lack of codified technical knowledge in schools due to the complexity and speed at which the environment changes, teachers must explore new techniques and new methods to be successful in the classrooms. Such exploration builds tacit knowledge in the system that must be distributed to others to learn and explore new ideas themselves. Successful exploration of new ideas leads to individual and organizational adaptation (March, 1999).

Toole and Louis (2002), as a summary of the preceding arguments, offer the following statements concerning the assumption by which networked learning communities influence teacher learning and pedagogical strategy. They state "that teaching is inherently a non-routine and complex activity (i.e., teachers will need to continue learning throughout their career); that there is a great deal of untapped knowledge already existing in schools; that the challenges teachers face are partly localized and will need to be addressed 'on the ground', and that teachers improve by engaging with their peers in analysis, evaluation, and experimentation" (p. 248).

Over the past few decades, more and more schools and school districts have come to support these conclusions by actively seeking ways to break the cycle of teachers working in silos by implementing mentoring programs and policies to promote communities of practice and

professional learning communities (PLCs). Thus, despite the historical tendency and professional norms for teachers to work in isolation (Goodlad, 1984; Lortie, 2002), schools are shifting the culture of the organization to encourage collaboration. The movement toward greater levels of teacher collaboration is motivated by the belief that dialogue and information exchange among teachers concerning the practice of teaching is central to individual and school success. As Bryk et al. state, "[q]uite simply, teachers learn a great deal about instructional practice from their local colleagues" (2010, p. 119). Because social connections are the avenues by which ideas and tacit knowledge travel, social network analysis is an ideal framework to analyze teacher collaboration (Penuel et al., 2009).

Penuel et al. (2009, p. 129) offer four main benefits of studying the social structure of faculty in schools, stating that network analysis can:

1. Provide a clearer understanding of the internal structure of school community;

2. Produce measures that help explain changes in teachers' attitudes and beliefs;

3. Provide useful information to policy makers and school leaders about the success of initiatives designed to promote greater collaboration in schools;

4. Provide tools to evaluate and improve initiatives aimed at enhancing instruction through the use of reform leaders.

To date, there is a small but growing research base on social networks in the education sector (Deal et al., 2009). In the following sections, this literature will be addressed alongside relevant organizational network research in other contexts. To help frame an overview of the literature, organizational network research and networks in educational contexts will be broadly categorized by the direction of analysis. The direction of analysis refers to whether networks are being used as predictors of some other organizational phenomena (i.e. consequences of

networks) or the network itself is the phenomenon to be explained (i.e. antecedents of networks). In addition to reviewing some work on the antecedents and consequences of networks, a third section will specifically discuss the role of social capital and social networks in schools.

2.2 CONSEQUENCES OF NETWORKS

The majority of organizational research employing social network analysis has been conducted with the primary goal of identifying the impact of networks structure on organizational phenomena. To this end, researchers have sought to understand how networks influence individual level outcomes as well as collective outcomes. Two of the most widely studied aspects of social networks in educational systems concern the implementation of organizational change and the structural dimensions of leadership.

Organizational Change and Reform: Studying the implementation of a district wide reform in literacy, Daly et al. (2010) found that social networks played an important role in facilitating and in some cases constraining the buy-in and implementation of the reform. Variation in the communication and collaboration structure existed both between schools and within the grade-level teams implementing the specific reforms. Daly et al. (2010) claim that the district's focus on human capital aspects of the reform (i.e. on the technical components and pedagogical strategies) and the lack of attention on how reform behaviors spread through informal social structures may have ultimately hindered the reform's success. Similarly, Atteberry and Bryk (2010) based upon their study of a literacy-based reform intervention,

conclude that social networks influence the degree to which a reform actually improves teaching and learning within the school.

Cole and Weinbaum (2010) analyzed the impact of social ties on reform attitudes rather than reform behavior. They found that if a teacher is tied to peers whose overall attitude toward reform is one standard deviation higher than his/her own, that teacher will increase his/her attitude toward the reform by .39 standard deviations. Given the role that attitudes have on behavior, this is a significant finding. Overall the work by Daly et al. (2010), Atteberry and Bryk (2010), and Cole and Weinbaum (2010) suggests that reformers looking to understand wide variation in the implementation and support of organizational change efforts would be wise to attend to the informal social structures of the implementing organization. Furthermore, at the micro-level, a small clique of teachers or a highly popular teacher could have a huge impact on the overall attitude and behavior of school level actors regarding reform efforts.

Leadership: Because an individual's position within an informal network has important implications for the peers to whom he/she is directly connected and to the organization as a whole, the relationship between social network structure and leadership is critical. Numerous studies have concluded that much of the work in modern organizations is performed through informal networks (Brass, 1995; Cross and Parker, 2004; Krackhardt and Hanson, 1993) and therefore, simply rearranging the formal organizational chart tends to have little impact on the overall functioning (Krackhardt and Hanson, 1993). The fundamental role of informal networks in shaping behavior and performance has begun to shift the ways in which we think about management and leadership in organizations.

In the organizational leadership literature, most studies focus on the attributes of leaders, such as ability, intelligence, and other characteristics (Brass and Krackhardt, 1999). While such

individual attributes are clearly an important component of leadership, what is often overlooked are the social structures and relationships that surround leaders. In fact, compared to other managers, those deemed *effective* managers spent much more of their time on communication (Luthans et al., 1988). Networking has also been shown as the key behavior for advancement in a company (Burt, 1992; Luthans et al., 1988). The social network perspective of leadership is important because relationships "provide access to, and control of, valuable resources; resources which enable one to make sense of, and successfully operate on one's environment" (Brass and Krackhardt, 1999, p. 182).

Hite et al. (2005) note that while organizational studies on the role of networks are well established in management research (Brass, 1984, 1985; Brass and Burkhardt, 1993; Bryson and Kelley, 1978; Krackhardt and Hanson, 1993; Tsai, 2001), the study of networks in educational leadership is not as well developed. Leadership in schools has historically focused on the role of the principal and other formally designated leaders. Recently, other forms of leadership have been shown to exist in schools and to play critical roles in directing and guiding the system. The concept of distributed leadership, developed by Jim Spillane (2001), focuses on the distribution of cognition among several actors within a school. The central argument of distributed leadership is that school leadership is best understood as a distributed practice that is grounded in both social and situational contexts.

Parallel leadership, introduced by Crowther et al. (2002, p. 38), is defined as "a process whereby teacher leaders and their principals engage in collective action to build school capacity." Parallel leadership, unlike distributed leadership, separates the tasks of leadership into two categories: (i) those assigned to the principal, such as strategic planning, resource aligning, and networking; and (ii) those assigned to the teachers, such as pedagogical leadership and

implementation of policy. Both the emerging concepts of parallel and distributed leadership view leadership as spanning the organizational unit and not simply vested in the individual at the top of the hierarchy.

Teachers who have been recognized as leaders within their school, such as those provided with teacher of the year awards, tend to be boundary spanners and networkers who work both within and across schools to establish social relations with key actors in the educational system (Acker-Hocevar and Touchton, 1999). Teachers who maintain more expansive networks are more likely to be leaders in the adoption of new technology and curriculum change (Riel and Becker, 2000). With regard to principal leadership, Moolenaar et al. (2010) found that a principal's position in the social network of the school was positively related to the overall innovative climate of the school. In earlier work related to networks and leadership, Friedkin and Slater (1994, p. 140) claim that "[c]entrality in an organization's informal communication network allows superiors to develop, maintain, and exercise their interpersonal influence." The work of Moolenaar et al. (2010) and Friedkin and Slater (1994) highlight the fact that a principal's position within the informal social structure of the school may have important implications for that school's progress and performance. From a network perspective, leadership involves not only one's ability to foster his or her own collaborative ties but also one's capacity to develop an organizational environment that supports and promotes collaboration among all members.

2.3 ANTECEDENTS OF NETWORKS

Research investigating the antecedents of social network formation generally emphasizes the role of two factors: structural and demographic.[2] Structural factors attempt to explain the formation of a particular tie based on the distribution of ties in the network. For instance, one of the strongest findings of social network formation is the tendency for ties to be reciprocated. When dealing with directed network data, the dyad can take on one of three possible isomorphic states: null (i.e. no ties), asymmetric (i.e. a single tie in one direction), and reciprocated (i.e. a tie in both direction). The proportion of reciprocal ties in a population is thought to be an important component in cohesion (Hanneman and Riddle, 2011). Many social network theorists believe there is a tendency for dyadic relations to evolve into more stable, equilibrium states, where dyads are either null or reciprocated (Hanneman and Riddle, 2011).

Transitivity, also referred to as triadic closure, is another common structural feature in social networks. To oversimplify, transitivity occurs when three individuals are all connected with one another. As described by Rapoport (1957), triads containing two ties will often lead to the formation of a third. Similarly, the first premise of Granovetter's strength of weak ties argument (Granovetter, 1973) leads to such transitive relations. Granovetter hypothesis is that the stronger the tie between two individuals, the greater the probability that those individuals will be tied to common third parties.

Beyond the endogenous effects of reciprocity and transitivity, there are exogenous effects of actor demographics. The common phrase "birds of a feather flock together" is based on the

[2] There is also a large literature on the role of propinquity in networks dating back to Festinger (1950). This work shows how physical proximity strongly affects tie formation. Despite the advent of information communication technology allowing individuals to connect and communicate across large distances, propinquity continues to play a significant role in determining the frequency and strength of interactions.

work of Byrne (1971) indicating that individuals tend to associate with similar others. Hinds et al. (2000) in their study of work group formation found that individuals had a strong preference to work with others of their same race even when controlling for familiarity and competence. Similarly, Gibbons and Olk (2003) found that similarity in personal attributes were important predictors of friendship formation among MBA students.

There is very little work on the antecedents of teacher social network structure in schools with regards to the development of statistical models predicting who interacts with whom.[3] There is however, research and theory on the types of environments that may lead to greater levels of collaboration within a school. Bryk et al. (1999, p. 771) suggest that to the extent that professional community within a school fosters actual changes in instructional practices "it does so by creating an environment that supports learning through innovation and experimentation."

Coburn et al. (2010) claim that there are two primary ways in which organizational contexts matter for the formation of social ties among teachers. First, an organization can influence the value its members place on expertise and second, an organization can affect its members knowledge of where expertise resides. The latter, which is often referred to as transactive memory "is a key component of collective problem solving, coordination, and group performance" (Coburn et al., 2010, p. 48). The authors go on to suggest that "leaders and policy makers can foster the development of the desire for expertise and the knowledge of where it is located by ensuring that teachers are engaged in generative tasks focused on teaching and learning during structured meetings" (p. 49).

[3] There is work on adolescent friendship formation in schools by Goodreau et al. (2009). This work applied an exponential random graph model to study the generative processes of social tie formation using student-level data from the National Longitudinal Study of Adolescent Health.

2.4 SOCIAL CAPITAL AND NETWORKS IN EDUCATIONAL SYSTEMS

The act of information exchange and collaboration among teachers in schools produce the fundamental linkages that structure social networks and consequently influence the stock of social capital (Moolenaar and Sleegers, 2010). One way networks generate social capital is by increasing the pool of ideas and teaching practices available to any teacher and thereby improving their individual and collective capacity. Hargreaves (2003, p. 9) suggests that a "network increases the pool of ideas on which any member can draw and as one idea or practice is transferred, the inevitable process of adaptation and adjustment to different conditions is rich in potential for the practice to be incrementally improved by the recipient and then fed back to the donor in a virtuous circle of innovation and improvement." Ultimately, and perhaps most importantly, teacher networks are viewed as a key factor in student learning as the relations teachers establish facilitate the opportunity to garner trust, exchange knowledge, generate ideas, explore the teaching craft, and expand skill sets (Daly et al., 2010).

Studies attempting to analyze the impact of social capital on teacher and school level outcomes can be seen as a subcategory of the consequences of network studies. This research tends to take one of two approaches. A non-structural approach, relying on survey items to measure social capital, and a structural approach, using social network analysis to map the structure of interaction. The non-structural approach has operationalized social capital in a variety of ways.

Coleman famously used the concept of social capital to explain why Catholic schools outperformed public schools based on the community structures that surround Catholic schools (Coleman and Hoffer, 1987; Coleman et al., 1982). Morgan and Sorensen (1999) challenged this explanation by attempting to predict math gain scores for students based on a measure of social

closure. Other research has relied on parental and adolescent (Furstenberg and Hughes, 1995; Rosenfeld et al., 2000) reports to measure social capital.

Rosenfeld et al. (2000) used a comprehensive instrument, the School Success Profile (SSP) to assess the extent to which a student perceived support from his or her important groups related to schooling: parents, teachers, and friends. The authors found that support combinations that included a high perceived support of teachers along with either friends or parents produced the highest means on school achievement. Their research provides evidence of the important and central role that teachers play in terms of social support for students. McNeal (1999) relying on the National Educational Longitudinal Study (NELS:88) used parental involvement as a measure of social capital. His longitudinal work indicated that social capital had a significant effect on behavioral outcomes of students (i.e. truancy and dropping out) but not on cognitive outcomes (i.e. science achievement).

Leana and Pil (2006), through their non-structural analysis of 88 urban schools, found that social capital was a critical factor for predicting performance in public schools. Leana and Pil operationalized social capital through survey items assessing the level of information sharing, trust, and shared vision, among the teachers in a school. These teacher level items were then aggregated to measure social capital at the school level. The authors found that social capital was predictive of student achievement in both math and reading.

In another non-structural study linking social capital to performance, Goddard (2003) found that social capital in a school had a positive and significant impact on the probability that a student would pass reading and math exams. Goddard operationalized social capital based on measures of teacher to teacher trust, the existence of an orderly work environment, and student

commitment. Interestingly, after controlling for social capital, the socio-economic status of the student was no longer a significant predictor of performance.

As Deal et al. (2009) note, very few studies have taken the structural approach by attempting to apply social network analysis (SNA) to the field of education. Because social capital is generated through social connections, it is useful to understand and measure teacher social capital by mapping the underlying social structure within a school (Penuel et al., 2009). The failure to assess the social connections among coworkers is a major limitation of the non-structural studies. Attempts at creating school level or district level policy to promote social capital without understanding the actual structure of social relations in a school could be misguided. As Easley and Kleinberg (2010, p. 61) note, the current research on social capital "does not yet specify what kinds of network structures are most effective for creating social capital."

Several researchers using a structural approach have begun to investigate the configuration of social networks within schools. Jim Spillane and his group at Northwestern have conducted multiple network surveys in schools as part of their work on distributed leadership (Spillane, 2005; Spillane et al., 2003; Spillane et al., 2001). An extensive study by Molenaar et al. (2010) developed network measures concerning principal social networks and used these measures to predict the innovative climate of the school. Some excellent work has been done in this area by examining how district policy regarding coaches can influence the shape of the social network (Coburn and Russell, 2008). Hawe and Ghali (2008) have also developed network maps of relations within a school as a method to assess which individuals might be most effective at pushing through an intervention. In 2010, an edited book was

published analyzing the role of social networks in education reform and highlights the influence informal structures have on educational issues (Daly, 2010).

2.5 SUMMARY

While the empirical findings from both the non-structural and structural studies regarding teacher social capital lend support to districts' strategies to generate social capital through improved collaboration, there is little understanding as to why teachers choose to collaborate in the first place.[4] Because connectivity between individuals is the basic element of social capital, there is value in knowing how individuals and groups cohere into particular structures. This study provides a critical next step in research on social capital in schools by investigating the processes by which such social connections emerge and cohere into school wide structures. Current research on social capital in schools offers little insight into these mechanisms as the vast majority of work solely looks at the consequences of network structure or some measure of social capital. Such information is vital, but it leaves little actionable knowledge to help schools improve the level of teacher collaboration. Therefore this study looks to build statistical models of teacher network formation and to enhance the literature on the consequences of network structure in schools for individual and collective performance.

Research evidence indicates that relationships matter for teacher (Leana and Pil, 2006), principal (Friedkin and Slater, 1994) and superintendent (Meier and O'Toole, 2005) performance. If we want to improve leadership and instruction in schools we cannot simply

[4] The Coburn and Russell (2008) study offers some insight into this issue, but only anecdotally. They do not provide any statistical modeling of the networks or network evolution.

focus on any single element, such as individual teacher attributes or the materials used in the classroom. Rather, we must look at the networks that emerge within schools and the information and resources that are shared across the ties linking actors to one another. Understanding how the structure of relations in schools impacts student performance can allow for policy planning at the district and school level to aid in the creation of collaborative relationships. Recent research has shown that district policy can influence the structure of networks and the content of information that flows through the network (Coburn and Russell 2008). The study intends to add to the growing literature on both the antecedents and consequences of network structure in schools.

3.0 DATA COLLECTION, RESEARCH DESIGN, AND METHODS

Data collection for this study occurred in 21 schools within a single school district. The following sections will provide a summary of the basic demographics and school level variables associated with the study along with an overview of the data collection procedures. In addition, an outline of the research design and methods used to carry out the study will be discussed.

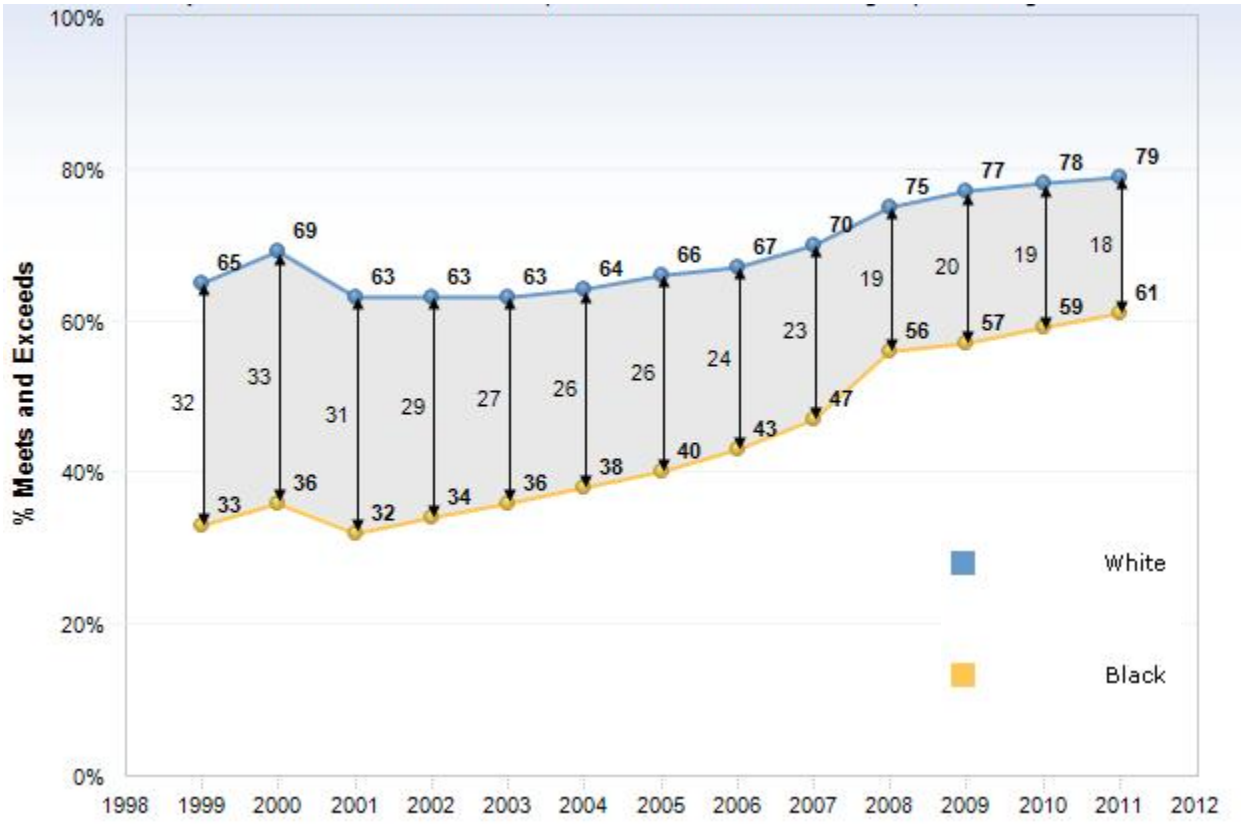
3.1 FIELD STUDY SITE: FINLEY SCHOOL DISTRICT

Finley School District[5] is a mid-sized urban district in the Midwestern United States. The district enrolls nearly 9,000 students in 21 schools. Finley is a majority-minority district serving 45.5% black students, 41.8% white, 9.6% multiracial, and 3.0% Hispanic, Asian, and American Indian. Of the 21 schools, 19 are Title I, indicating that at least 40% of the student population in the school is low-income. In total, 70% of all students in the Finley School District are low-income.

Despite small, but steady growth, the district has failed to make adequate yearly progress (AYP, a No Child Left Behind indicator of school progress) for the past eight years and continues to battle a significant achievement gap as shown in Figure 2.

[5] Finely is a pseudonym to protect the identity of the district.

Figure 2. Percentage of Students Meeting or Exceeding Standards on State Reading Exams



Within the district, the schools themselves are somewhat heterogeneous concerning student population and performance. Table 1 below provides an overview of the schools involved in the study.

Table 1. Demographics of Schools in Finley School District

School	Grade Levels Taught	Number of Students	Percentage of Low Income Students	Percentage of Minority Students	Percentage of Students Meeting or Exceeding State Standards (All Subjects)
Site 1	9-12	1,081	61%	57%	29%
Site 2	9-12	1,226	60%	57%	42%
Site 3	7-8	488	68%	56%	74%
Site 4	7-8	457	76%	53%	68%
Site 5	K - 6	305	80%	56%	62%
Site 6	K - 6	194	83%	41%	74%
Site 7	K - 6	267	76%	53%	69%
Site 8	K - 6	315	95%	76%	69%
Site 9	K - 6	218	81%	63%	72%
Site 10	PK - 8	367	39%	38%	88%
Site 11	K - 8	390	87%	84%	66%
Site 12	K - 8	496	53%	61%	86%
Site 13	K - 6	321	75%	74%	70%
Site 14	K - 6	403	70%	36%	80%
Site 15	K - 6	321	65%	46%	80%
Site 16	K - 6	325	82%	55%	75%
Site 17	K - 6	280	70%	55%	73%
Site 18	K - 6	364	67%	53%	67%
Site 19	K - 6	285	74%	54%	78%
Site 20	K - 6	222	92%	71%	58%
Site 21	Pre-K	448	72%	47%	NA[6]

3.2 DATA COLLECTION

The five research objectives of this study required a unique dataset containing information about individuals, organizations, social relations, and cognitive perceptions. To collect the necessary information, four data collection procedures/components were utilized: network surveys,

[6] Test score data is unavailable for this school since it does not contain any grades for which standardizing testing occurs.

qualitative interviews, perception surveys, and administrative data. Each will be covered in detail below.

3.2.1 Network Survey

The Network Survey was the primary data collection instrument. In April of the 2010-2011 school year, teachers, principals, and staff in each of the 21 schools in the Finley School District were invited to respond to a survey regarding informal social structure within schools along with a range of additional survey items. Response rates in the 21 schools varied from 52% to 95% with an overall response rate of 73%. In total, 512 of the potential 701 teachers, principals, and staff members participated in the survey.

For each school, an actor specific survey was generated based on the individual's role within the school. Thus, a Teacher Network Survey, a Principal Network Survey, and a Staff Network Survey[7] were developed. While each survey contained a different set of questions, the questions concerning the measurement of affective and instrumental social ties within a particular school were common to each of the three surveys.

School actors were asked to identify the coworkers with whom they held three distinct relationships. First, participants were asked about their affective ties and were directed to indicate the level of friendship they maintained with other teachers in the school. Friends were defined as 'people with whom you like to spend free time, people with whom you go to dinner, visit each other's homes, or attend social events'. A roster of teacher, principal, and staff names was provided along with five categories of friendship ranging from 'Just Coworkers' to

[7] Staff members of the school consisted of counselors, social workers, nurses, and other support staff.

'Especially Close Friends'. Second, participants were asked about instrumental ties concerning information and knowledge exchange. Teachers were directed to indicate which coworkers they sought advice or information from concerning the practice of teaching, ideas on lesson planning, classroom management or other work related advice. The same roster of coworker names was given to the participant along with five options for rating the frequency of interaction ranging from 'Never' to 'Daily'. Third, and similar to the previous relationship, participants were asked to identify the individuals who came to them for advice. Once again, the question provided a roster of coworker names along with five categories indicating the frequency of interaction.

For each of these three relations, an individual actor's response was aggregated with the other respondents in the school to form an n X n adjacency matrix, where n is the number of actors in the school. Each row in the adjacency matrix indicated a single actor's claim of a relation with each of the other n-1 actors. Given the five ordinal response categories, the friendship and advice networks were weighted from zero to four. The dyadic interaction, $Y_{i,j}$, is defined as a random variable for the tie between actor i and actor j. For example, in the friendship network, $Y_{i,j} = 4$, if i claims that j is an 'especially close friend', and $Y_{i,j} = 0$ if i claims j is 'just a coworker'. The links between actors i and j are non-symmetric or directed, and thus $Y_{i,j} \neq Y_{j,i}$ for all i,j.

In addition to these network questions, a different set of survey items were given to teachers, principals, and staff.

3.2.1.1 Teacher Network Survey

The teacher survey was the most extensive of the three network surveys and contained survey items designed to measure 10 additional concepts. An example of the Teacher Network Survey and the specific items used to measure each concept can be found in Appendix B.

Reflective Dialogue. The 8 items used to measure reflective dialogue and socialization came from the Consortium on Chicago School Research (CCSR).[8] Factor analysis produced two distinct factors. The first factor, REFD (α=0.820) captures the amount of time a teacher claims to have engaged in reflective dialogue with coworkers concerning student learning, curriculum, goals, and classroom behavior. The second factor, SOCZ (α=0.789) captures the extent to which a teacher perceives the collective group of teachers partaking in discussions about instruction and engaging new faculty.

Collaboration. The 5 items used to measure teacher collaboration came from the CCSR. Factor analysis produced two distinct factors. The first factor, COLB_TOG (α=0.824) captures the amount of time teachers worked together on instructional and assessment strategies. The second factor, COLB_OBS (α = 0.715) captures the amount of time teachers spent observing another's classroom.

Collective Responsibility. The 5 items used to measure one's sense of collective responsibility came from the CCSR. Factor analysis revealed only one underlying factor, COLR (α = 0.919).

Innovative Climate. The 5 items used to measure a teacher's perception of the innovative climate of his or her school came from the CCSR. Factor analysis revealed only one underlying factor, INNV (α = 0.893).

School Commitment. The 7 items used to measure one's organizational commitment came from a combination of three scales: CCSR, Porter and Smith (1970), and Rosenholtz (1991). Factor analysis produced two separate factors. The first factor, SCMT_ORG (α = 0.785),

[8] The Consortium on Chicago School Research (CCSR) was created in 1990 to study the long-term of effects of the school restructurings that occurred in Chicago Public Schools. The organization has developed an extensive set of survey items to measure key variables associated with school culture and performance. The surveys and scales developed by the CCSR can be found at http://ccsr.uchicago.edu/content/index.php.

indicates a teacher's level of commitment to his or her specific school. The second factor, SCMT_PROF (α = 0.757) indicates a teacher's level of commitment to the profession of teaching in general.

Self-Efficacy. The 9 items used to measure self-efficacy came from the Tschannen-Moran and Woolfolk Hoy (2001) short form of the efficacy scale. The scale was designed to measure three different aspects of efficacy with regards to teaching. Factor analysis revealed the same factors and loadings as established by Tschannen-Moran and Woolfolk Hoy. The first factor, EFFIC_CM (α = 0.842) measures a teacher's sense of self-efficacy with regards to classroom management. The second factor, EFFIC_SE (α = 0.822) measures a teacher's sense of self-efficacy with regard to student engagement. The third factor, EFFIC_IS (α = 0.777) measures a teacher's sense of self-efficacy with regard to developing good instructional strategies for his or her students.

Teacher Trust. The 7 items used to measure teacher trust came from a combination of two scales: CCSR and Rosenholtz (1991). Factor analysis revealed a single factor, TRTE (α = 0. 892).

Instructional Leadership. The 9 items used to measure instructional leadership came from the CCSR. These items were designed to assess the teacher's perception of the instructional leadership of the principal. Factor analysis revealed a single factor, INST (α = 0.967)

Teacher Influence. The 6 items used to measure teacher influence came from the CCSR and were designed to measure the amount of influence the teachers have in the operations and management of the school and classroom. Factor analysis revealed two factors. The first factor, INFL_SCH (α = 0.792) captures teacher influence in broader management issues at the school

level. The second factor, INFL_CLS ($\alpha = 0.835$) captures teacher influence at a more narrow classroom level.

Informal Leaders. This survey item asked teachers to identify from a roster list of fellow teachers the individuals they perceive as informal leaders in the school. An informal leader was defined as "someone other teachers look up to and while not holding an official position of power, have the capacity to influence or lead others". There was no maximum nor minimum number of teachers that could be nominated as informal leaders.

3.2.1.2 Principal Network Survey[9]

Principal to Principal Advice Network. This survey item asked principals to identify other principals in the district with whom he or she went to for advice to discuss professional matters such as school and teacher management, curriculum, community outreach, or organizational change. Each principal was given a roster list of the other principals in the district and asked to indicate the frequency with which they interacted ranging from 'never' to 'daily'.

Human Resources. The 5 items used to measure the principals perception of the dedication of his/her teaching staff came from the CCSR. Factor analysis revealed a single factor, HRE ($\alpha = 0.889$).

Effective Teachers. The 7 items used measure the principal's perception of the effectiveness of the teachers in his or her school came from the CCSR. Factor analysis revealed a single factor, EFF ($\alpha = 0.901$).

Roadblocks. The list of 17 potential roadblocks to school success came from the CCSR. See Appendix B for a full list of the potential roadblocks in the Principal Survey.

[9] These items not used in current analysis.

Commitment. The 4 items used to measure principal commitment came from the CCSR. Factor analysis revealed two underlying factors. The first factor, CMT_SCH, measures the principals commitment to his or her specific school ($\alpha = 0.954$). The second factor, CMT_SPT, measures the amount of support the principal perceives (Cronbach's alpha could not be calculated as only a single item loaded on this factor).

Informal Leaders. This survey item asked principals to identify from a roster list of teachers the individuals who are informal leaders in the school. An informal leader was defined as "someone other teachers look up to and while not holding an official position of power, have the capacity to influence or lead others". There was no maximum nor minimum number of teachers that could be nominated as informal leaders.

3.2.1.3 Staff Network Survey[10]

Human Resources. The 5 items used to measure the staff's perception of the dedication of the teaching staff came from the CCSR. Factor analysis revealed a single factor, HRE ($\alpha = 0.910$).

Effective Teachers. The 7 items used measure the staff's perception of the effectiveness of the teachers in their school came from the CCSR. Factor analysis revealed a single factor, EFF ($\alpha = 0.869$).

Informal Leaders. This survey item asked staff members to identify from a roster list of teachers the individuals who are informal leaders in the school. An informal leader was defined as "someone other teachers look up to and while not holding an official position of power, have

[10] These items not used in current analysis.

the capacity to influence or lead others". There was no maximum nor minimum number of teachers that could be nominated as informal leaders.

3.2.2 Qualitative Interviews and the Perception Survey

Because this study is interested in understanding both the structural and psychological aspects of social network formation, a second survey was conducted to gather data on interpersonal perceptions among teachers. Prior to the design and development of the Perception Survey, extensive qualitative interviews were conducted. The goal of the interviews was to develop a list of the salient personality traits/constructs that teachers rely on or use when comparing their coworkers within the school environment. In order to establish the list of relevant traits, George Kelly's (1955) role repertory grid was utilized. The implementation of the grid, which consists of an elicitation stage (which occurred during the qualitative interviews) and a rating stage (which was carried out through the Perception Survey) are covered in detail in Chapter 4.

The Perception Survey contained 11 traits salient to the formation of social ties in schools and asked each teacher to rank each of his or her coworkers along the 11 traits. Such a task, while providing a wealth of interpersonal perception information, is a cognitively demanding and time consuming task. Because of this, only six schools, all elementary schools, were chosen from the 21 schools in the Finley School District to participate in the Perception Survey. Elementary schools were chosen over middle schools or high schools in the district due to the smaller number of teachers in elementary schools. Schools were chosen based on response rates to the network survey. Perception data needed to be linked with network data for analysis, and thus schools were specifically targeted to allow for the largest possible within-school sample.

The selected schools showed no significant differences from the non-selected elementary schools on student demographics or performance indicators.

Table 2. Demographics of Schools in Finley School District Participating in the Perception Survey

School	Grade Levels Taught	Number of Students	Percentage of Low Income Students	Percentage of Minority Students	Percentage of Students Meeting or Exceeding State Standards (All Subjects)
Site 1	K-6	267	76%	53%	69%
Site 2	K-6	315	95%	77%	69%
Site 3	K-6	218	81%	63%	72%
Site 4	K-6	403	70%	37%	80%
Site 5	K-6	321	65%	47%	80%
Site 6	K-6	222	92%	72%	58%

As shown in Table 2, the six elementary schools are rather heterogeneous with regard to student population, percentage of low income students, percentage of minority students, and overall performance. The response rate on the Perception Survey was significantly lower than the Network Survey. Overall, the Perception Survey received a 51% response rate (62 out of 122 teachers).

3.2.3 Administrative Data

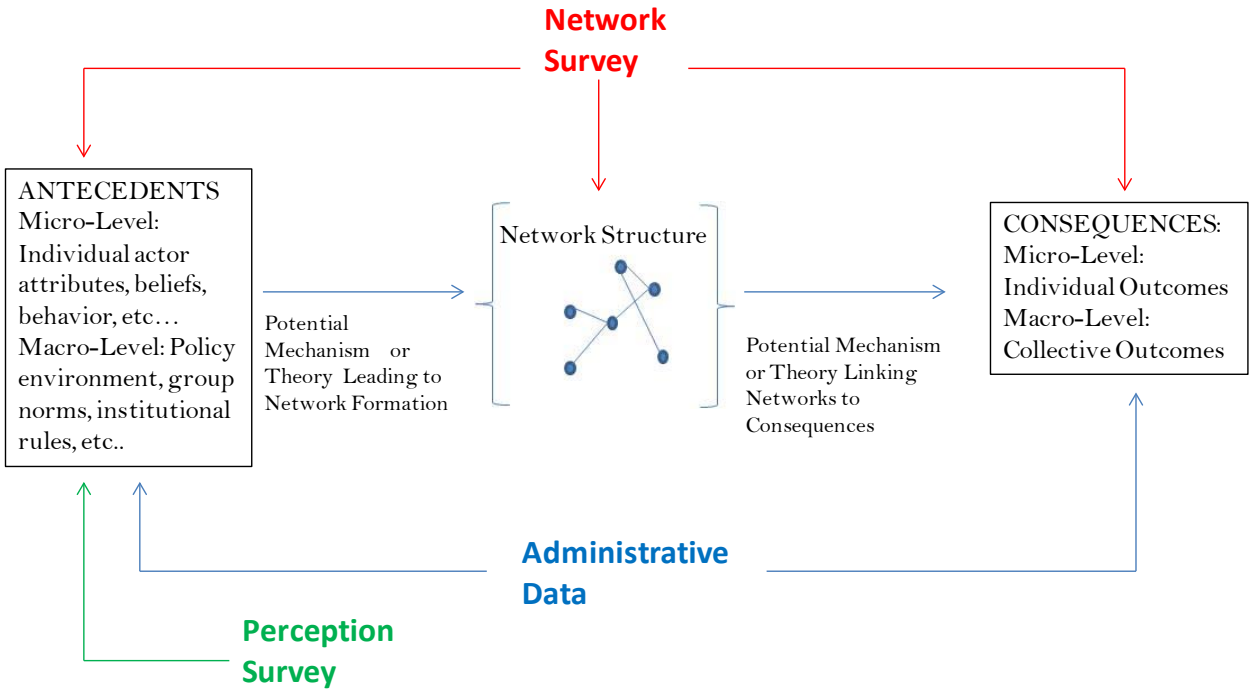
In addition to the social network and survey data collection, exogenous attributes of the teachers were also obtained through the surveys and from the district's administrative database. These attributes are age, gender, race, grade level taught, education, years with current school, and years in the district. More importantly, the district provided four years of student achievement data (from the 2007/2008 school year to the 2010/2011 school year), that is anonymous at the student level, but is linked to specific teachers. The data, consisting of

approximately 20,000 entries, contains student level demographics and their scores on the state exams in reading, math, science and writing. The longitudinal test score data for reading and math will be used to develop value-added models of teacher and school performance. The methodology used to calculate value-added will be discussed in Chapter 7.

3.3 RESEARCH DESIGN AND METHODS

Various combinations of methods and data were joined together to achieve the five research objectives. Figure 3 provides a graphical overview of where the various types of data that were collected fit into the network framework used in the study.

Figure 3. Use of the Network Survey, Perception Survey, and Administrative Data



The first research objective concerning the identification of personality traits and frames of reference was approached through the elicitation stage of the role repertory grid. The method and results are discussed in Chapter 4.

The second research objective, regarding the statistical modeling of social network formation used data from the Network Survey and the Perception Survey, as well as administrative data. A multiple regression quadratic assignment procedure (MRQAP) is used to model the factors associated with tie formation in public schools and to deal with the issue of non-independence associated with network data. Chapter 5 details the specific procedures used in MRQAP, the model specifications for the friendship and advice network formation, and the results of the analysis.

The third research objective, seeking to model and measure the influence of individual network position and the moderating role of organizational level variables on individual attitudes/beliefs uses the Network Survey and administrative data. In Chapter 6 multilevel models are used to capture the between and within school effects of network variables on teacher outcomes.

The fourth research objective, aiming to provide a stronger measure of social capital and to assess how different types of networks impact different outcomes, uses data from the Network Survey. Unlike previous studies which tend to rely on a simple centrality score or a list of survey items to measure social capital, this study determines the value of each tie based on the strength of connection to an alter and the resources held by that alter. The development of these measures of social capital are discussed in Chapter 7. With regard to the effect of different types of networks on different outcomes, Chapter 6 generates multilevel models and network autocorrelation models.

The fifth research objective, attempts to assess the effect of networks on individual performance. The administrative data provided by the district allowed for the calculation of value-added models of teacher performance. Value-added scores provide an objective estimate of student achievement gains that can be attributed to a specific teacher in a specific year. Chapter 7 links the social capital measures with the value-added scores and teacher network data to assess the relationship between networks, social capital, and individual level performance

4.0 MEASURING INTERPERSONAL PERCEPTION

The pioneering work by the American psychologist George Kelly (1955) on the repertory grid technique offers a systematic means to understand how individuals perceive and interpret their lived experience. The technique aids in the operationalization of interpersonal perception by allowing individuals to supply the relevant constructs that define their experience. Unlike other cognitive methodologies, the emphasis of the grid technique is on the mental constructions of the situations and events individuals face in their daily environments. The resulting mental constructions are the frames of reference of the individuals operating in the context under study. There is a myriad of ways in which one can utilize the repertory grid technique and for a thorough review see Fransella et al. (2004). This section will detail the specific approach taken in this study.

The role repertory grid, or grid technique, in the current context was used to develop a list of the most relevant traits teachers draw on to compare their coworkers in the school environment. To this end, the grid technique operated in two phases. The first phase involved the elicitation of the constructs and the second phase involved the rating of individuals or roles based on those constructs. Unlike the standard grid method where the same individual who provided the constructs also provides the ratings, this study relied on a small sample of teachers to generate the list of relevant constructs and traits. This list was then provided to each of the teachers in the study schools, via the Perception Survey, in order to provide consistent and

comparable data between teachers and between schools. Upon completing the rating phase, the repertory grid produces an *m* X *n* matrix of *m* constructs (i.e. traits) and *n* elements (i.e. teachers) capturing the interpersonal perceptions of teachers with regard to a wide range of relevant constructs.

4.1 ELICITATION STAGE

In order to elicit the constructs that would be given to the teachers in the six study schools, a sample of 12 public school teachers from five public school districts in the Eastern and Midwestern United States took part in the elicitation phase. Different school districts were incorporated to assess whether the same constructs would arise across different public school contexts. If similar constructs surfaced, one can be more confident that the elicited constructs are applicable and relevant to a broad spectrum of teachers within the public school system. The sample consisted of nine female teachers and three male teachers. Table 3 below reveals the demographics of the teachers. The schools from which the teachers were selected were determined based on the researcher's pre-existing relations with the districts and school leadership. The selection of teachers was based on school type, age, and subject taught, in order to achieve a wide range of perspectives.

Table 3. Demographics of Teachers Participating in Elicitation Stage

Teacher	School Type	Subject	Gender	Experience
1	Elementary	Special Ed	F	19
2	Elementary	Multiple	M	8
3	Elementary	Special Ed	F	31
4	Elementary	Multiple	F	4
5	Elementary	Multiple	F	10
6	Middle	Reading/English	F	11
7	Middle	Math	F	8
8	Middle	Math	F	6
9	Middle	Special Ed	M	3
10	High School	Reading/English	F	8
11	High School	Science	F	7
12	High School	Math	M	13

Each of the 12 teachers were interviewed for approximately 75-90 minutes using the grid technique to bring forth the constructs. These constructs would eventually be used in the Perception Survey of public school teachers from the Finley School District. Because the teachers in the sample were from different schools, the elements initially supplied to them were in the form of generic role types. Participating teachers were presented with role types and asked to provide an individual's name fitting that role type within his or her home school. Associating a real person with the role grounds the study and facilitates the process of comparison that drives the grid technique. The following role types were given to the participants: principal, curriculum coach, assistant principal, guidance counselor/social worker, team leader/department chair, teacher I am friends with, teacher I am not friends with, teacher I go to for advice, and teacher I do not go to for advice.

Some teachers worked in schools that did not have a curriculum coach or an assistant principal. In these instances that element was removed and names were provided for the remaining seven or eight roles. Once the element set was defined, the elicitation of the constructs began though the triadic method and was aided by the software program Idiogrid (Grice 2002). The Idiogrid software would randomly select three names from the list provided

by the interviewee. The teacher would then be asked "In what way are two of these people alike and different from the third?" The trait defining the similarity between two of the actors that differentiates them from the third constitutes a construct. For particular triads, interviewees would sometimes offer simplistic similarities regarding age, gender, or hair color. In these instances, the interviewees were prompted to focus on more psychological similarities as opposed to superficial ones. In other words, the interviewee would be probed for deeper differences. Once a construct emerged by comparing the elements in the triad, the opposite pole was also obtained. It is important to obtain the opposite pole as two individuals may have different meanings or understanding of a given construct. As Fransella et al. (2004) note, the construct of charitable may have different meanings to different people. For one individual the opposite pole may be intolerant and for another it may be to hold strong opinions. By obtaining the two ends of construct, one can more easily interpret the underlying meaning of the verbal label provided by the participant.

Once the construct and its opposite pole were elicited from the teacher, a new, randomly selected triad was presented and the same question was posed. In total, the participant would be presented with up to 20 different triads. The interview could conclude at a number less than 20 if the participant was unable to provide any additional constructs. Krackhardt and Kilduff (1990, p. 144) citing the work of Hunt (1951) claim that "[r]esearch has shown that each individual has only a limited number of constructs relevant to any particular domain, and that few new constructs are elicited after 20 or so triads have been presented."

After the interviewees had gone through all of the randomly selected triads, what resulted was a list of psychological labels representing bipolar constructs. These constructs represent the frame of reference used by the individual in distinguishing between actors in his or her school.

These constructs function as a lens through which that teacher perceives his or her coworkers and therefore influences social interaction.

The construct elicitation interviews occurred over a period of several weeks. As each interview was completed, the list of constructs generated across all participants was assessed and compared. On average, each teacher produced 11.6 constructs with a standard deviation of 1.9. In total, the 12 teachers interviewed produced 140 constructs. While the wording or verbal label each participant used to describe the construct may not match exactly, the underlying idea or trait may hold similar conceptual meanings. For instance, one teacher offered the bipolar construct of *team-player versus self-interested* while another teacher used the terms *collaborative versus self-serving*. Different verbal labels expressing similar underlying concepts were grouped together as a single item.[11] The process of matching conceptually similar verbal labels resulted in reducing the 140 constructs down to 33 unique constructs; 24 of which were mentioned more than once. Table 4 lists all of the constructs that were mentioned by more than one teacher and the percentage of times mentioned.

[11] This same process also occurred for the constructs of a single teacher. During the interview a teacher could provide a conceptually similar set of verbal labels for two distinct triads. If the similarity between the constructs was not caught by either the software program or the interviewer, then redundant concepts would exist within a single teacher's construct list. A few teachers provided as many as 18 constructs. However, when going back over the list with the teacher at the conclusion of the interview, several constructs were seen as having similar meaning. If during the interview, it was noted that a similar construct was mentioned to one previously given, the participant would be directed to consider a new way in which to compare the three individuals.

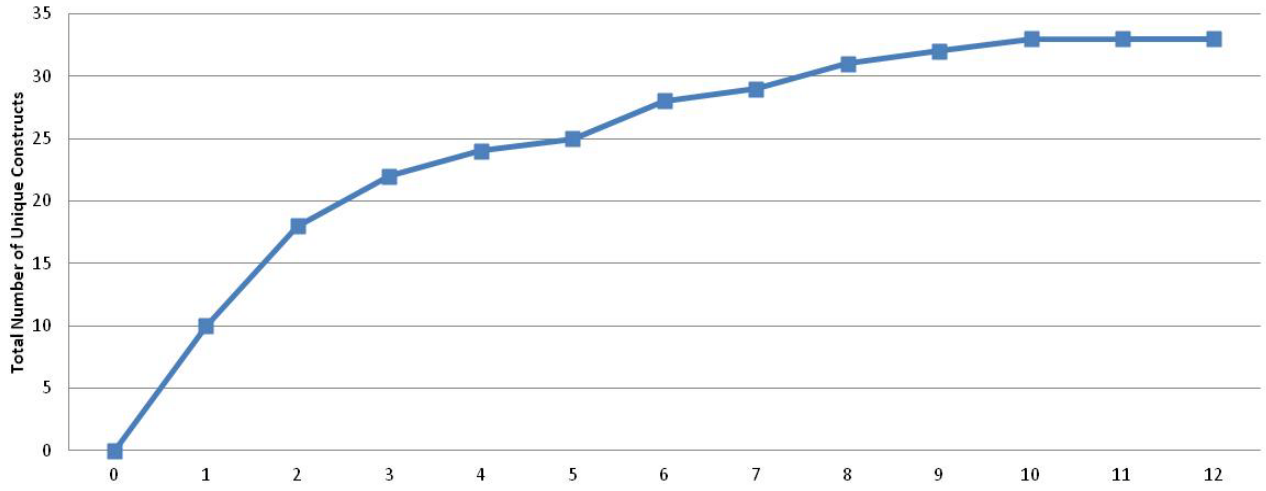
Table 4. All Unique Constructs Mentioned by Two or More Teachers

Summarized Pole	Summarized Opposite Pole	Percent Mentioned
Collaborative, Team Player	Self-Concerned, Self Serving	91.7%
Caring, Nice, Nurturing	Mean, Cold, Insincere	91.7%
Open Minded, Open to New Ideas	Closed Minded, Set in Ways	83.3%
Hard Working	Lazy	75.0%
Flexible, Calm, Easy Going	High Strung, Controlling	66.7%
Modest, Humble, Open to Criticism	Cocky, Cannot Accept Criticism	58.3%
Competent, Knowledgeable	Less Competent, Less Knowledgeable	50.0%
Happy, Positive, Friendly	Pessimistic/Depressing	50.0%
Good Listener, Easy to Talk To	Not Easy To Talk To, Poor Communicator	50.0%
Approachable	Unapproachable	50.0%
Trustworthy	Untrustworthy	50.0%
Quiet Leader, Leads by example	Authoritative, Argumentative	41.7%
Fun, Bubbly, Outgoing	Serious, Dry	41.7%
Reliable	Unreliable	33.3%
Creative	By the Book	33.3%
Keeps students on task	More Lenient, Lets things go	33.3%
Detailed oriented	Big Picture Person	33.3%
Organized	Unorganized	25.0%
Efficient with time	Inefficient with time	25.0%
Embraced by Students, Good with Kids	Disliked by Students, Inept with Kids	25.0%
Morally Invested, Dedicated to Students	Loyal to Power Structure, Plays Politics	25.0%
Resourceful	Less Resourceful	16.7%
Experienced	Inexperienced	16.7%
Normal	Strange/Peculiar	16.7%

The number of teachers necessary to complete elicitation stage of the grid technique was determined by the reduction in the number of unique constructs generated by conducting an additional interview. Previous work by Dunn and Ginsberg (1986) indicate that the majority of all relevant constructs can be obtained from a very small sample. Thus, at some point, adding new participants to the elicitation phase of the study adds no new information in terms of new

constructs. The graph below depicts the number of unique constructs generated from each of the 12 interviews. There is a clear leveling off after ten interviews where no additional constructs were obtained that were substantively different from the ones provided by the nine teachers previously interviewed. Thus, the number of participants in the elicitation phase was limited to 12.

Figure 4. Number of Unique Constructs per Additional Interview

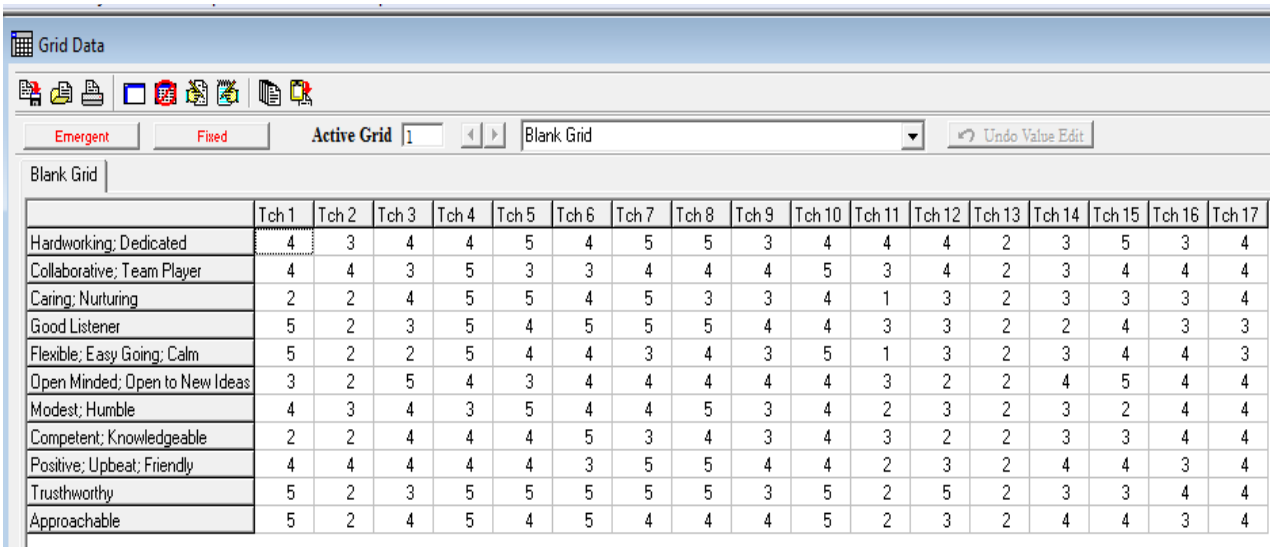


4.2 RATING STAGE

Based on Table 4, the 11 traits or constructs with a 50% or greater frequency of occurrence were chosen to be included in the rating phase which was carried out through the Perception Survey. This phase of the grid technique concerned the ranking of individuals along each of the 11 constructs identified during the elicitation phase. So a teacher in a school comprised of 18 teachers, would have been asked to rate the 17 other teachers on each of the 11

traits as well as rate him or herself. The resulting data, as displayed in the Idiogrid software program, is shown below.

Figure 5: Example of Grid Data in the Idiogrid Software Package



	Tch 1	Tch 2	Tch 3	Tch 4	Tch 5	Tch 6	Tch 7	Tch 8	Tch 9	Tch 10	Tch 11	Tch 12	Tch 13	Tch 14	Tch 15	Tch 16	Tch 17
Hardworking; Dedicated	4	3	4	4	5	4	5	5	3	4	4	4	2	3	5	3	4
Collaborative; Team Player	4	4	3	5	3	3	4	4	4	5	3	4	2	3	4	4	4
Caring; Nurturing	2	2	4	5	5	4	5	3	3	4	1	3	2	3	3	3	4
Good Listener	5	2	3	5	4	5	5	5	4	4	3	3	2	2	4	3	3
Flexible; Easy Going; Calm	5	2	2	5	4	4	3	4	3	5	1	3	2	3	4	4	3
Open Minded; Open to New Ideas	3	2	5	4	3	4	4	4	4	4	3	2	2	4	5	4	4
Modest; Humble	4	3	4	3	5	4	4	5	3	4	2	3	2	3	2	4	4
Competent; Knowledgeable	2	2	4	4	4	5	3	4	3	4	3	2	2	3	3	4	4
Positive; Upbeat; Friendly	4	4	4	4	4	3	5	5	4	4	2	3	2	4	4	3	4
Trusthworthy	5	2	3	5	5	5	5	5	3	5	2	5	2	3	3	4	4
Approachable	5	2	4	5	4	5	4	4	4	5	2	3	2	4	4	3	4

The data for teachers within the same school were transformed into a single trait matrix, where each teacher's row for a particular trait was combined with every other teacher's row for that particular trait. This process formed 11 different *n* X *n* matrices, one for each trait, where *n* is the number of teachers in that school. Hence, a single trait matrix for a single school contains each teachers perception of every other teacher along that particular trait. Each of the trait matrixes for any given school were identical in dimensions to the matrices of the social ties among the teachers in the school. The transformed trait matrices will be used to model social network formation in Chapter 5.

5.0 STATISTICAL MODELS OF THE ANTECEDENTS OF NETWORKS

Statistical models capable of capturing the processes of network formation have become increasingly sophisticated (for a general overview see section three in Scott and Carrington, 2011). A major difficulty in modeling the antecedents of social networks arises from the fact that the relations formed within a network are not independent of one another, causing problems for estimating models using standard statistical techniques that require independent observations. It is crucial to utilize analytic methods that take into account the inherent dependency among the dyads in the network under study (Monge and Contractor, 2003). Two methods most relevant to the current pursuit of investigating the antecedents of teacher network structure are exponential random graph models (ERGMs), also referred to as p* models, and the multiple regression quadratic assignment procedure (MRQAP).[12]

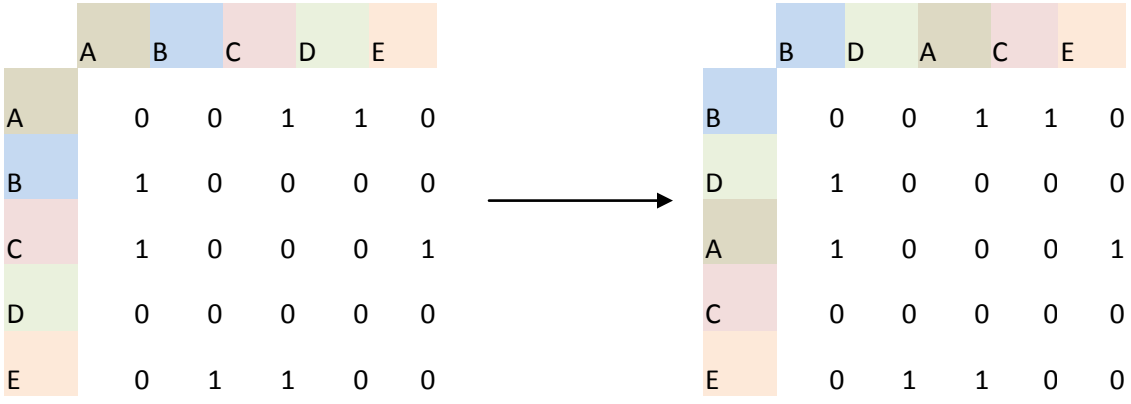
ERGMs offer a flexible method for generative network formation (Robins et al., 2007; Wasserman and Pattison, 1996) allowing for multiple parameters to be tested simultaneously. For advances in estimation techniques see Handcock et al. (2008) and Snijders et al. (2006). However, these models have mainly been implemented for, and are most stable for, binary dependent variables. The network data collected as part of this study is continuous and

[12] A third method, known as the social relations model (Kenny et al. 2006) could also be used to model the data. However, the social relations model makes an assumption of dyadic independence, which does not seem plausible for the current study. Even with the significant amount of missing data in the networks there are important structural effects that need to be controlled for.

therefore, MRQAP (Dekker et al., 2007; Krackhardt, 1987, 1988) was chosen as the method of analysis given the ease with which the method handles non-binary data.

MRQAP provides a regression-like methodology for investigating associations between two variables on a dyadic basis. One could use standard regression to predict the size of the relationship between each pair of actors, but the non-independence among dyads will tend to underestimate the standard error. In the bivariate case, MRQAP uses a simple permutation method by repeatedly permuting the order of the actors in the dependent variable while keeping the independent variable unaltered. This permutation process preserves the overall structure and number of ties in the network, but alters which actor holds which position. Thus, removing the relationship between the independent and dependent variable. Figure 6 below illustrates the permutation process of a five person network.

Figure 6. Example of the Permutation Process of the Quadratic Assignment Procedure



Once the dependent variable has been permuted, a coefficient is calculated based on the association between the permuted dependent matrix and the original independent matrix. The dependent variable is then permuted again, and a new coefficient is calculated. This process of permutation and coefficient calculation is repeated numerous times to produce a distribution of

coefficients. The observed coefficient between the original two matrices is then compared to this reference distribution, and the appropriate level of significance can be assigned based on the observed coefficient's location in the distribution. For example, if less than 5% of the coefficients in the reference distribution are more extreme than the observed value, then the observed relationship can be considered significant at the .05 level. When MRQAP is extended to the multivariate case, the residuals are used in the permutation procedure (see Dekker et al., 2007).

5.1 MODELING SOCIAL NETWORK FORMATION IN SIX STUDY SCHOOLS

The data collection discussed in Chapter 3 produced three distinct types of data that will be used to model network formation: network data, demographic/attribute data, and trait/perception data. Figures 7 and 8 below provide a visual depiction of the advice seeking and friendship networks that existed in the six study schools. Because these networks are weighted from 0-4, only the ties with a value of 3 or higher are shown in the figures. The mapping and statistical analysis of the network data was done in the **R** programming language (R Core Development Team, 2011) using the **statnet** suite of packages (Handcock et al., 2003).

Figure 7. Network Diagrams for Advice Seeking Behavior in the Six Study Schools

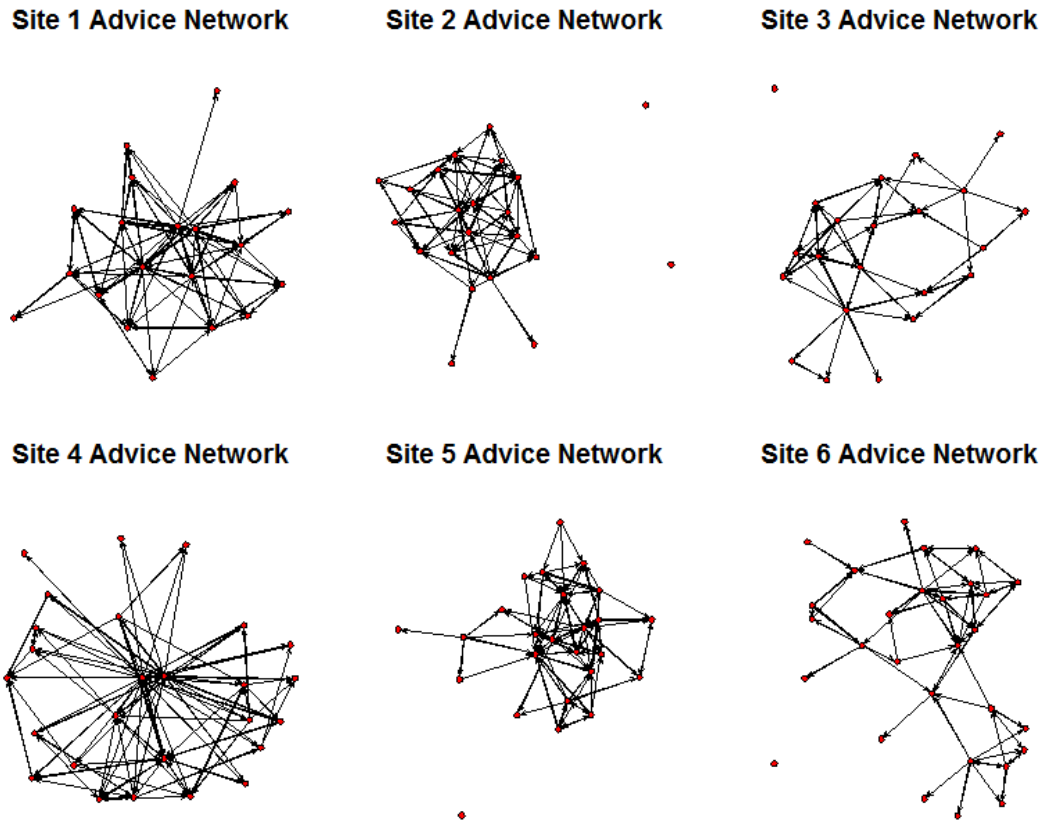
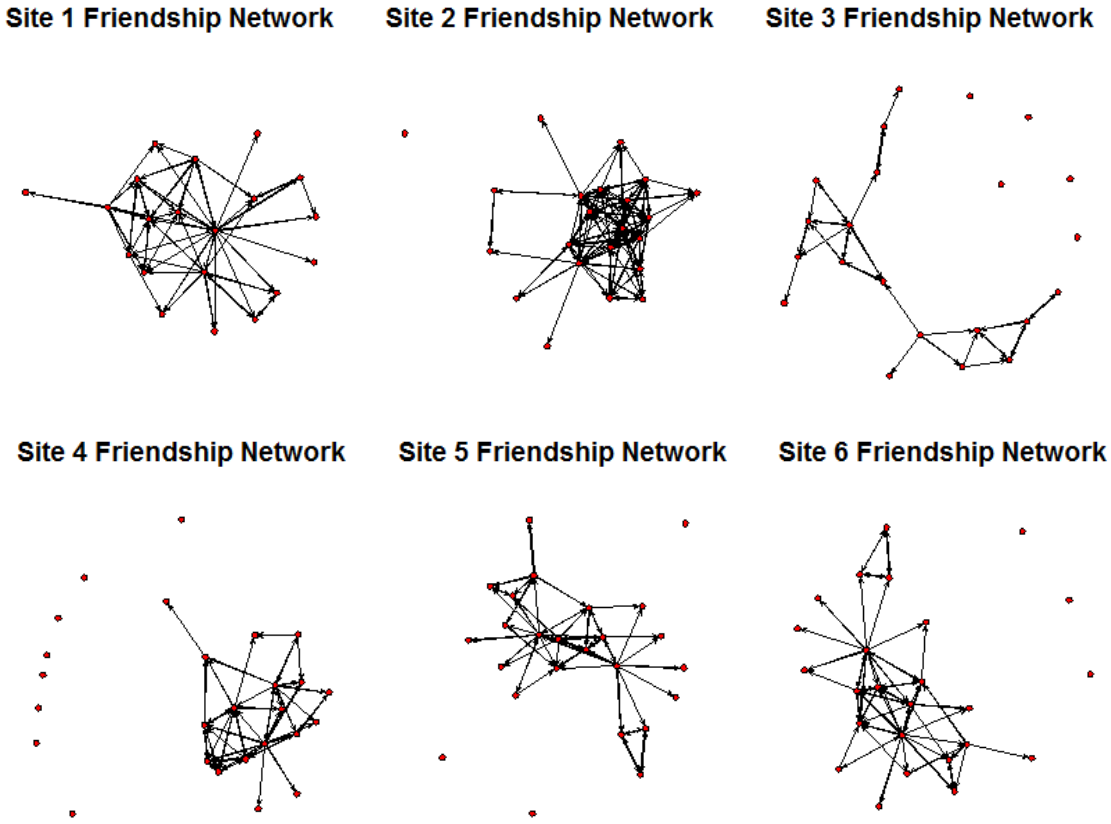


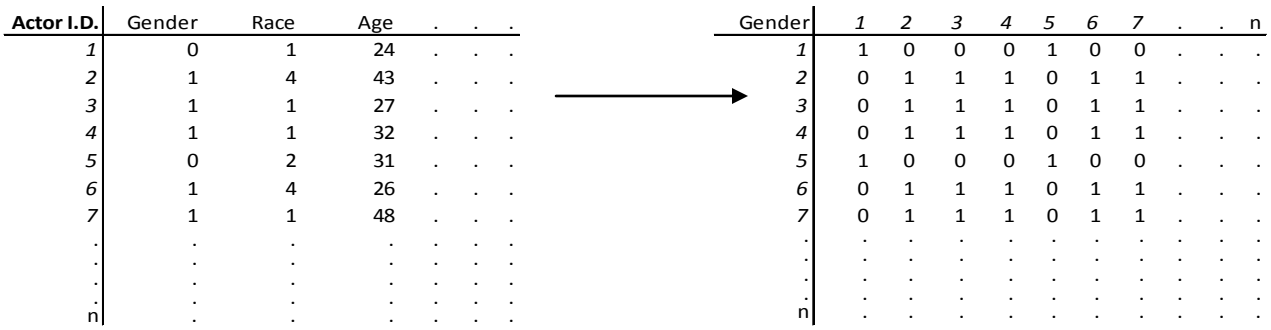
Figure 8. Network Diagrams Friendship Ties in the Six Study Schools



Prior to analysis using MRQAP, each demographic variable needed to be transformed into an *n* X *n* square matrix to match the format of the network data, where *n* is the number of teachers in a school. The demographic data was originally structured in a standard cross-sectional format, where the rows represented the actors and the columns represented the demographic variable. Each demographic variable was then transformed into an *n* X *n* matrix through a pairwise comparison of actor scores. For dichotomous variables, the *i*,*j* cell in the transformed matrix was assigned a 1 if *i*'s demographic value equaled *j*'s demographic value. In other words, if *i* and *j* were of the same gender, then *i*,*j* = 1, otherwise, *i*,*j*=0. This process continued pairwise through all actors. For continuous variables, such as age, the *i*,*j* cell

represented the difference in the ages between actor *i* and actor *j*. An image of the transformation process for the demographic variables is shown below.

Figure 9. Transforming Demographic Variables



Actor I.D.	Gender	Race	Age	.	.	.
1	0	1	24	.	.	.
2	1	4	43	.	.	.
3	1	1	27	.	.	.
4	1	1	32	.	.	.
5	0	2	31	.	.	.
6	1	4	26	.	.	.
7	1	1	48	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
n	.	.	.	.	.	.

Gender	*1*	*2*	*3*	*4*	*5*	*6*	*7*	.	.	n
1	1	0	0	0	1	0	0	.	.	.
2	0	1	1	1	0	1	1	.	.	.
3	0	1	1	1	0	1	1	.	.	.
4	0	1	1	1	0	1	1	.	.	.
5	1	0	0	0	1	0	0	.	.	.
6	0	1	1	1	0	1	1	.	.	.
7	0	1	1	1	0	1	1	.	.	.
.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.
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.	.	.	.	.	.	.	.	.	.	.
n	.	.	.	.	.	.	.	.	.	.

In addition to restructuring the demographic data to capture dyadic differences, the perception/trait data was factor analyzed prior to being incorporated into the MRQAP models. As is visually apparent from Figure 5 and statistically confirmed in Table 5 below, the traits are highly correlated. In the language of George Kelly and personal construct psychologists, we find that individuals have rather tight systems of construing. In the context of the work environment, school teachers tend to have a stable perception of their coworkers across a range of relevant dimensions of personality. If a teacher perceives another teacher as being highly approachable, she also tends to see that person as highly trustworthy, caring, etc… Therefore, there is likely an underlying latent factor or set of underlying latent factors.

Table 5. Correlation Matrix for Traits (Aggregated Across All Six Sites)

	Approachable	Trustworthy	Caring	Competent	Collaborative	Flexible	Good Listener	Hardworking	Modest	Open minded	Positive
Approachable	1										
Trustworthy	0.800	1									
Caring	0.752	0.758	1								
Competent	0.652	0.723	0.707	1							
Collaborative	0.698	0.704	0.779	0.669	1						
Flexible	0.642	0.674	0.705	0.613	0.723	1					
Good Listener	0.787	0.768	0.811	0.677	0.750	0.747	1				
Hardworking	0.635	0.698	0.727	0.760	0.703	0.585	0.647	1			
Modest	0.654	0.727	0.698	0.646	0.668	0.662	0.690	0.619	1		
Open minded	0.663	0.645	0.714	0.627	0.787	0.775	0.740	0.637	0.632	1	
Positive	0.759	0.700	0.752	0.669	0.714	0.755	0.728	0.651	0.612	0.765	1

Due to the implications of high levels of multi-collinearity on standard error estimates, a factor analysis was conducted and produced three distinct latent variables. The traits of open-minded, positive, flexible, and team player were found to load highly on the first factor, which will be termed the Amity Factor. The traits of competent and hardworking loaded highly on the second factor, which will be termed the Work Factor. Finally, the traits of trustworthy and approachable loaded highly on the third factor, which will be termed the Trust Factor. As with the original perception data, the factor analysis scores represent teacher *i*'s cognitive perception of teacher *j*. The Amity, Trust, and Work perception matrices were used in the MRQAP models to capture the psychological component of networking behavior in schools. Bivariate analysis showing the correlation between each trait matrix and each network matrix is available in Appendix A.

The full MRQAP model thus consisted of three cognitive factors, identified through factor analysis, as well as the demographic predictors[13] of age, education, grade level taught, and tenure (i.e. number of years a teacher had been with his or her current school). For the model analyzing friendship behavior, the absolute value of the difference score on the demographic factors was calculated for each pair of teachers. The absolute value was used rather than the actual difference as the direction of the difference was not theoretically relevant. For instance, if homophily is at work in the friendship network, we would expect to find that teachers who are of a similar age or have been in the school for a similar number of years are more likely to be friends than individuals with wide differences in age or tenure. Thus, the effect of these predictors on friendship formation should be the same regardless of whether the friendship is from *i* to *j*, or from *j* to *i*. It is the distance separating the actors rather than the direction of the distance that is of interest.

In the advice seeking models, the absolute value was used for the grade level term only. For age, education, and tenure, the actual difference between teacher *i* and teacher *j* was used as the predictor. Unlike friendship, where ties may form between teachers who have similar scores on the demographic predictors, advice behavior is hypothesized to be driven by a different dynamic. Teachers may be more likely to seek advice from those who have higher education levels, are older, or are more seasoned teachers in the school. Thus, it is important to know not only the size of the difference but also the direction of the difference. If teacher *i* has been in the school for 3 years and teacher *j* has been there for 30, the existence of an advice seeking relationship is most likely to emerge in the direction of *i* to *j* and rather than from *j* to *i*.

[13] Two predictors unsuitable for analysis were gender and race. Both of these demographic attributes had very little variance within the school. Most of the teachers tended to be of the same race and gender.

In general, the basic linear model for square matrix data, with k demographic variables (X) and m perception variables (Z) is:

$$Y = \delta_1 X_1 + \delta_2 X_2 + \cdots \delta_k X_k + \beta_1 Z_1 + \beta_2 Z_2 + \cdots \beta_m Z_m + \epsilon.$$

Prior to the analysis, the following hypotheses are offered.

Friendship Model:

Hypothesis One: The Amity Factor will have a positive effect on friendship tie formation.

Hypothesis Two: The Work Factor will have a positive effect on friendship tie formation.

Hypothesis Three: The Trust Factor will have a positive effect on friendship tie formation.

Hypothesis Four: The coefficient on the absolute value of age difference will be negative, indicating that teachers with greater distances between their ages will be less likely to form strong friendships.

Hypothesis Five: The coefficient on the absolute value of education differences will have no effect on friendship formation.

Hypothesis Six: The coefficient on the absolute value of grade level differences will be negative, indicating that a tie is more likely to form between a 2nd and 3rd grade teacher than between a 1st and 5th grade teacher.

Hypothesis Seven: The coefficient on the absolute value of tenure differences will be negative, indicating that teachers who were hired by the school around the same year are more likely to be friends.

Advice Seeking Model:

Hypothesis One: The Amity Factor will have a positive impact on advice seeking behavior.

Hypothesis Two: The Work Factor will have a positive impact on advice seeking behavior.

Hypothesis Three: The Trust Factor will have a positive impact on advice seeking behavior.

Hypothesis Four: The coefficient on age difference will be negative, indicating that a teacher is more likely to seek out an older coworker for advice than a younger coworker.[14]

Hypothesis Five: The coefficient on education difference will also be negative, indicating teachers seek out coworkers with advanced degrees for advice.

Hypothesis Six: The coefficient on absolute grade level difference will be negative, indicating that a teacher is more likely to seek advice from a coworker who teaches in the same grade.

Hypothesis Seven: The coefficient on tenure difference will be negative, indicating teachers seek out longer tenured coworkers for advice.

The results of the analysis are displayed in Table 6 below.

Table 6. Results of the MRQAP Analysis in the Six Study Schools

	Site 1	
	Friendship	Advice
Intercept	1.708***	1.683***
Amity Factor	0.377***	0.241**
Trust Factor	0.158	0.188**
Work Factor	0.010	0.169*
Age	-0.050***	0.021
Educ	-0.236*	0.094
Grade	0.207	-0.073
Tenure	0.070	0.040
R-Squared	0.165	0.171

	Site 4	
	Friendship	Advice
Intercept	-0.263	0.994**
Amity Factor	0.078	0.320
Trust Factor	0.145	-0.087
Work Factor	0.059	-0.368
Age	0.036	-0.043*
Educ	0.161	-0.403*
Grade	-0.092	-0.174
Tenure	0.049	-0.411
R-Squared	0.367	0.599

[14] Note that a negative coefficient supports the notion of homophily. If the actual difference in age is negative (younger person seeking out older person) and the coefficient on age is negative, then there is an increased likelihood of advice seeking as the age gap increases.

	Site 2	
	Friendship	Advice
Intercept	3.435***	2.251***
Amity Factor	0.921***	0.369
Trust Factor	0.232	0.655**
Work Factor	-0.494	-0.522
Age	-0.046**	0.002
Educ	-0.481	0.181
Grade	0.128	-0.132
Tenure	-0.200	0.324
R-Squared	0.436	0.358

	Site 5	
	Friendship	Advice
Intercept	1.953***	1.358***
Amity Factor	0.175	0.091
Trust Factor	0.236*	0.328***
Work Factor	-0.186	-0.016
Age	-0.033***	-0.018*
Educ	-0.095	0.220
Grade	-0.164***	-0.123**
Tenure	-0.013	-0.147
R-Squared	0.185	0.142

	Site 3	
	Friendship	Advice
Intercept	1.158***	1.242***
Amity Factor	-0.007	-0.111
Trust Factor	0.185*	0.241**
Work Factor	0.262**	0.385***
Age	0.016	-0.011
Educ	-0.093	0.230
Grade	-0.026	-0.090*
Tenure	-0.205*	-0.154
R-Squared	.0260	0.362

	Site 6	
	Friendship	Advice
Intercept	1.412***	0.832***
Amity Factor	0.136	0.173*
Trust Factor	-0.042	0.059
Work Factor	0.280	0.412***
Age	-0.037**	-0.005
Educ	0.084	0.068
Grade	0.057	-0.032
Tenure	0.011	-0.091
R-Squared	0.099	0.210

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level; all significance tests are one tailed in the direction hypothesized. As no effect was predicted for education level in the friendship model, the direction hypothesized in the advice model will be used for the purposes of hypothesis testing.

The results of the MRQAP analysis suggest that cognitive perception plays an important role in the formation of friendship and advice ties but the size and significance of the effect varied across the sites. With regard to the friendship networks, in five of the six sites, the Amity Factor had a positive effect on the strength of friendship between teachers and the effect is statistically significant in two of the sites. Similarly, the Trust factor had a positive effect on friendship tie formation in five of the six sites and the effect is statistically significant in two of the sites. The Work Factor was only significant in one of the sites, but carried a positive coefficient in four of them. With regard to the other predictors concerning demographic or

professional attributes, there was some evidence of homophily in friendship tie formation in the direction hypothesized. Age carries the hypothesized negative coefficient in four of the sites and was found to be significant in all four. Education, grade, and tenure were significant in one site each. For education, grade, and tenure the significant effects were in the direction hypothesized.

With regard to the advice seeking models, the Amity factor had a positive and significant coefficient in two of the sites. The Trust Factor, which had the strongest evidentiary base, was found to have a positive and significant coefficient in four of the sites. The Work Factor was shown to have a positive and significant coefficient in three of the sites. As with the friendship model there was some evidence of homophilous effects with age and grade being significant in two sites each and education being significant in one.

The variation in results, in terms of significance of the factors, presented an ideal opportunity to engage in meta-analysis to gain a better understanding of the population level effect of the variables on friendship and advice tie formation.

5.2 META-ANALYSIS OF THE MRQAP MODELS

The goal of meta-analysis is to estimate a summary effect across a range of studies by computing a weighted mean effect. Organizational network research offers both opportunities and challenges for conducting meta-analysis. Network research that has been carried out in multiple sites by the same researcher offers a unique opportunity to combine studies that used the same measurement instrument and statistical model in each site under investigation.

The Q statistic in meta-analysis is a measure of weighted squared deviations used to assess heterogeneity in results across the studies being synthesized (Borenstein et al., 2009). The

Q statistic allows the researcher to determine whether the slope coefficients found in the model for each study are statistically different from one another. If significant heterogeneity is not found across the sites then one can interpret the synthesized results as coming from a common population. The Q statistic as defined by Hedges and Olkin (1985) is applicable in a range of contexts, but not for the autocorrelated structures that are found in network analysis (Krackhardt and Kilduff, 1999). Krackhardt and Kilduff (1999) extended the use of the Q statistic to include primary research analyses that faced issues of autocorrelation and relied on nonparametric statistics. Because the nonparametric MRQAP model does not produce an estimate of the standard error associated with the slope coefficients, the permuted values of the coefficient estimates that are generated during MRQAP can be used to calculated the value of the standard error of the coefficient (Krackhardt and Kilduff, 1999).

The Q statistic is calculated as:

$$Q = \sum_{i=1}^{k} \left[\frac{(\beta_i - \beta_+)^2}{\hat{\sigma}^2_{(\beta_i)}} \right],$$

where β_i is the study effect size, β_+ is the summary effect, $\hat{\sigma}^2_{(\beta_i)}$ is the study weight, and *k* is the number of studies. Therefore, the deviation of each effect size from the overall effect size is squared and weighted by the inverse-variance of that study. The sum of these values for all *k* studies produce an estimate of the weighted sum of squares or the Q statistic (Borenstein et al., 2009, p. 109). The measure of standard error or study weight, $\hat{\sigma}^2_{(\beta_i)}$, was estimated by calculating the variance of each coefficient across the 1,000 permutations conducted as part of the MRQAP analysis (Krackhardt and Kilduff, 1999).

The summary effect, β_+, which is a pooled measure of the overall slope estimate of a predictor in the model, is calculated by:

$$\beta_+ = \frac{\sum_{i=1}^{k}\left[\frac{\beta_i}{\hat{\sigma}^2_{(\beta_i)}}\right]}{\sum_{i=1}^{k}\frac{1}{\hat{\sigma}^2_{(\beta_i)}}},$$

where, *k* is the number of slopes being combined, β_i is the slope from study *i*, and $\hat{\sigma}^2_{(\beta i)}$ is the weight for study *i* (Becker and Wu, 2007).

Table 7 shows the results of the Q statistic, which is distributed as a chi-square with *k*-1 degrees of freedom.

Table 7. Q Statistic Results

Friendship All Six Sites Combined

	Q	*p*-value
Amity Factor	6.14606	0.29227
Trust Factor	1.28281	0.93669
Work Factor	7.08461	0.21442
Age	13.39129	0.01998
Educ	3.82763	0.57449
Grade	10.63641	0.05909
Tenure	4.12420	0.53168

Advice All Six Sites Combined

	Q	*p*-value
Amity Factor	4.25906	0.51275
Trust Factor	4.05644	0.54132
Work Factor	11.27220	0.04624
Age	3.62376	0.60475
Educ	2.41012	0.78997
Grade	2.15455	0.82737
Tenure	4.18360	0.52330

The calculation of the Q statistic for each variable in each network model indicated that only two variables out of 14 exhibited a significant level of heterogeneity. In the friendship models, age was the only variable significant at the .05 level. In the advice models, the Work Factor was on the border of significance at the .05 level. Given that our primary variables of

interest are the cognitive factors and that only the Work Factor in the advice model indicated a sign of possible heterogeneity, the meta-analysis that follows will be interpreted as representing a common underlying population. Fisher's method was used to determine the overall level of significance of the pooled summary effect. Fisher's method of combining p-values is calculated as:

$$X^2 = -2\sum_{i=1}^{k} ln(p_i),$$

where p_i is the one-sided p-value from the study *i*, and *k* is the number of studies (Borenstein et al., 2009). Note, the p-values used in calculating the overall significance were derived from one-sided tests based on the hypothesized direction of the effect. Therefore, because the absolute value of age difference had an hypothesized negative effect on friendship tie formation, the p-value was calculated using a lower-tailed test. Similarly, the Amity Factor was hypothesized to have a positive effect on friendship tie formation and hence its p-value was based on an upper-tailed test. For this reason, the coefficients with negative values do not have a p-value greater than .5. The results of the meta-analysis are shown in the table below.

Table 8. Meta-Analysis Results Across all Six Sites

Friendship All Six Sites Combined

	β_+	*p*-value	
Amity Factor	0.17000	0.00341	***
Trust Factor	0.15286	0.06935	*
Work Factor	0.04266	0.34339	
Age	-0.01652	0.00377	***
Educ	-0.06133	0.32072	
Grade	-0.00101	0.25766	
Tenure	-0.00039	0.39236	

Advice All Six Sites Combined

	β_+	*p*-value	
Amity Factor	0.13243	0.04642	**
Trust Factor	0.20603	0.00198	***
Work Factor	0.15533	0.00365	***
Age	-0.00418	0.38547	
Educ	0.08755	0.83639	
Grade	-0.07040	0.01872	**
Tenure	-0.04053	0.31647	

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level; all significance tests are one tailed in the direction hypothesized.

Consistent with the general direction of the findings of the individual school analysis, the meta-analysis revealed that the Amity Factor and the Trust Factor were significant predictors of friendship tie formation. In addition, a significant homophilous effect based on age was also found to influence friendship tie formation. All three of the cognitive factors were shown to be significant predictors of advice tie formation. The Trust Factor, however, was 1/3 larger than the next biggest factor. The grade level taught by a teacher was also shown be a significant predictor of the advice tie formation.

5.3 THREATS TO VALIDITY

Given the non-experimental and cross-sectional design of the study, it is possible that the causal direction of the relationship between cognitive perception and social behavior specified in the model could be reversed. It could be that friendships initially form and then individuals develop perceptions of each other based on the structure of their social interaction. However, individuals tend to form perceptions of each other within very short time frames and it is these perceptions that are believed to influence social behavior (Kenny, 1994).

Previous research has indicated that individual frames of reference are quite durable cognitive structures. Longitudinal organizational studies have demonstrated that the passing of time, along with organizational socialization, have little effect on individuals' personal constructs (Arnold and Nicholson, 1991). Duck and Spencer (1972) showed that commonality in the ways individuals construe their social relations tends to be a precursor of friendship formation and not merely its product.

While there is evidence to support the belief that perceptions occur a priori of a social tie forming, the existence of a social tie will nonetheless begin to adjust the original perceptions held as individuals either live up to or fail to meet the expectations of their peers. Friendship and collaboration may increase in intensity and frequency if one's initial positive perception of another is confirmed. Thus, there is a dynamic at play between perception and behavior that cannot be captured by this study. Future studies using a longitudinal approach could track the changes in strength of friendship and changes in interpersonal perception to better understand this complex relationship in schools.

The use of meta-analysis to explore population level effects may mask important contextual issues within schools that may be relevant in how ties form between individuals.

While all of the schools are part of the same district and the Q statistic provided evidence that the slopes do not differ significantly, researchers have argued that individual choices about tie formation are partly shaped by the social and organizational contexts in which those ties emerge (Coburn et al., 2010).

5.4 CONCLUSIONS

The previous models offer a first step toward research on the antecedents of social network formation in schools that controlled for the structural dependency in network data while being able to model both homophily effects based on attributes and psychological effects based on interpersonal perceptions. Analysis of the data provides support for the main hypotheses, hypothesis one, two, and three, in both the friendship and advice seeking models. Cognitive perception as described in the social psychology literature appears to be a driver of social interaction as measured through social network questionnaires.

Schools interested in promoting teacher dialogue and teacher collaboration need to be aware of the effect of interpersonal perceptions. Many schools have found that their attempts at building professional learning communities have failed, resulting in what has been termed "contrived collegiality" rather than creating meaningful teacher collaboration (Hargreaves, 1994). This highlights a potential problem when attempting to develop network structures within schools as some external policies may not be effective. Social networks are emergent structures that tend to self-organize. Supporting this claim, Wasley (1991) found that when asked to nominate leaders in schools, individuals were more likely to select informal leaders as opposed to those assigned to formal leadership positions. Schools may find the most effective policies at

promoting collaboration are simply providing or improving the conditions under which self-organized collaboration can occur rather than directly attempting to structure interaction. Developing programs to improve coworkers ability to see each other as, and actually be, better listeners and more trustworthy may be more effective policies than designating formal time for teacher interaction or choosing a teacher to lead organized discussions on the practice of teaching.

While this analysis provides a foundation for thinking about social capital in schools from a theoretical, methodological, and policy perspective, there is much work to be done. Future studies will want to take a longitudinal approach to study the potential interacting dynamics between perception and social behavior. Additional studies should also consider other factors influencing network formation. One factor not included in this model that has proven to be predictive in other settings is physical distance. Teachers who have rooms adjacent to one another may be more likely to form social ties simply due to the frequency with which they informally interact based on their co-location.

6.0 CONSEQUENCES OF NETWORK STRUCTURE - BELIEF AND BEHAVIOR

Two longstanding issues faced by schools and school districts with regard to teachers are (i) turnover, and (ii) effectiveness. Teacher turnover is a growing problem in public education. Recent studies indicate that 46% of all new teachers leave the profession within five years (NCTAF, 2007). In the school district of Philadelphia, the dropout rate among new teachers is 70% and well surpasses the dropout rate among its students of 42% (NCTAF, 2007). The costs of teacher attrition nationwide have been estimated at over $7 billion, and increase each year as the turnover rates continue to climb (NCTAF, 2007). Finding ways to keep new teachers in the school system, especially in poor urban systems, is critical.

Equally critical is the pursuit and implementation of cost effective policies and programs to improve teacher effectiveness. Recent work by Chetty et al. (2011) found that replacing a teacher whose value-added score is in the bottom 5% with a teacher whose value-added score is near the mean, results in students gaining an average of $52,000 more in cumulative lifetime earnings. Work by Sanders and Rivers (1996) found that students with similar initial achievement levels can have vastly different performance just two years later based on the sequence of teachers to which those students were assigned. Sanders and Rivers (1996) found differences in student achievement as large as 50 percentile points between students who were at the same level of achievement just two years prior.

A range of research on the topics of teacher turnover and teacher performance have demonstrated that these issues are influenced by measures of organizational commitment and self-efficacy. These two variables will be the primary focus of this chapter. Porter et al. (1974) defined organizational commitment "in terms of the strength of an individual's identification with and involvement in a particular organization. Such commitment can be characterized by at least three factors: (a) a strong belief in and acceptance of the organization's goals and values; (b) a willingness to exert considerable effort on behalf of the organization; (c) a definitive desire to maintain organizational membership" (p. 604). Commitment is thus seen as an intrinsic motivating factor (Katz and Kahn, 1978) leading employees to work harder and experience higher levels of job satisfaction. Turnover in an organization is often a symptom of an organizational culture where employees have little organizational commitment (Mowday et al., 1982). Research on the antecedents of organizational commitment has shown a positive relationship exists between an employee's age, time with an organization, and level of commitment (Allen and Meyer, 1990).

Rosenholtz (1991) argues that teacher commitment is a direct function of the professional fulfillment teachers derive from their work. School leaders can improve teacher retention and organizational commitment by monitoring class sizes, including teachers in school decision making, displaying strong instructional leadership, and offering collegial learning opportunities (Darling-Hammond, 2003).

Self-efficacy is defined as a person's perception of how well he or she can implement strategies to perform successfully on a specific task (Bandura, 1982). Bandura (1977) theorized that individual beliefs about self-efficacy strongly influence behavior with regard to effort and perseverance. Consequently, as demonstrated by a meta-analysis of 114 studies, individuals

who hold higher perceptions of self-efficacy tend to have more successful work outcomes (Stajkovic and Luthans, 1998). The self-efficacy of teachers has been defined as an "individual teachers' beliefs in their own ability to plan, organize, and carry out activities that are required to attain given educational goals" (Skaalvik and Skaalvik, 2010, p. 1059). Tschannen-Moran et al. (1998), note that a teachers sense of efficacy is often tied to the climate of the school, the leadership of the principal, a sense of school community, and decision-making structures. Most importantly, self-efficacy has been shown to be significantly related to student achievement (Tschannen-Moran and Hoy, 2001; Tschannen-Moran et al., 1998).

Because self-efficacy and organizational commitment play such an important role in the successful functioning of schools, this section covers two different analyses related to modeling these outcomes. Both of these interrelated sections seek to improve our understanding of how the distribution of social ties among actors in a network influence individual and group outcomes. Individuals may receive benefits based on network structure in two primary and interconnected ways. One, based on the resources and knowledge available to the actors through their social connections and two, based on the positions individuals hold within the network. Groups benefits may arise from contexts that facilitate communication, coordination, and innovation.

The first analysis used multilevel modeling to assess both the individual and school level factors influencing variation in self-efficacy and commitment. These models measured and incorporated several network variables as predictors. The second analysis utilized network autocorrelation models to test the idea that efficacy and commitment might not only be shaped by one's own attributes and overall network activity, but also by the efficacy and commitment of the colleagues to whom one is connected in the network. The primary goal of the analyses is to

understand if, and how, social ties and network structure effect conceptions of self-efficacy and commitment.

6.1 MODELING INDIVIDUAL AND SCHOOL LEVEL EFFECTS

6.1.1 Outcome Variables

Organizational Commitment: Two different aspect of organizational commitment were measured. The first, SCMT_ORG ($\alpha = 0.785$), indicates a teacher's level of commitment to the specific school he/she works in, while the second, SCMT_PROF ($\alpha = 0.757$) indicates a teacher's level of commitment to the profession of teaching. A teacher's commitment to a school and to the profession can vary dramatically. For instance, a teacher may feel a strong sense of connection to the continued pursuit of being a teacher, but due to school culture or poor leadership may have limited commitment to his or her current organization.

Teacher Self-Efficacy: Three distinct aspects of teacher self-efficacy were measured. The first, EFFIC_CM ($\alpha = 0.842$) measures a teacher's sense of self-efficacy with regard to classroom management. The ability to manage a classroom has to do with one's ability to generate and maintain an orderly learning environment. The second, EFFIC_SE ($\alpha = 0.822$) measures a teacher's sense of self-efficacy with regard to student engagement. Student engagement captures one's ability to influence student desire to learn and succeed academically. The third, EFFIC_IS ($\alpha = 0.777$) measures a teacher's sense of self-efficacy with regard to

developing good instructional strategies for his or her students. Thus, instructional strategies relate directly to pedagogical tactics and techniques of instruction.

When the terms "efficacy" and "commitment" appear below they should be interpreted as referring to the general variable; when the specific individual factors associated with these variables are addressed they will be specifically named.

Network Variables

The ten non-efficacy and non-commitment variables measured in the survey (see Section 3.2.1.1 for a full description) were tested as possible predictors of the three efficacy and two commitment variables. In addition to these ten survey items, several network variables were calculated and used as predictors in the statistical models. The individual level network variables of weighted in-degree centrality and weighed out-degree centrality along with the network level variables of principal centrality and network density were measured.

Weighted In/Out-Degree Centrality: Degree centrality, defined as the number of connections an individual has with other actors in the network, was originally defined for binary networks (Freeman, 1979). One can differentiate between in-degree, meaning the number of incoming ties an individual receives, and out-degree, the number of outgoing ties an individual sends. In-degree centrality for actor *i* can be formally defined as:

$C_I(i) = \sum_{j=1}^{n} x_{ji}$,

where x is the adjacency matrix, *i* is the focal node, and *j* represents all other nodes that can send a tie to *i*. Thus, x_{ji} equals 1, if actor *j* sends a tie to actor *i*. Similarly, out-degree centrality for actor *i* can be formally defined as:

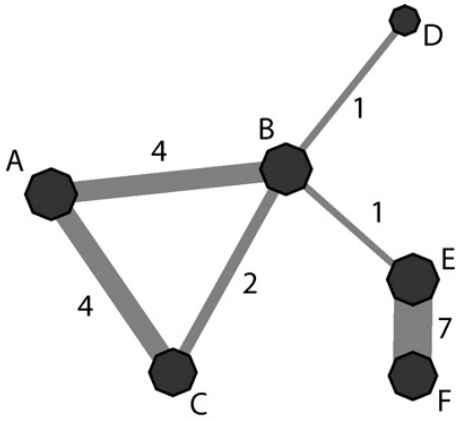
$C_O(i) = \sum_{j=1}^{n} x_{ij}$.

Many network datasets, including those gathered in the current study, contain more detailed data about the relationship between actor *i* and actor *j* than the simple absence or presence of a tie. Rather than indicating whether or not there is a link connecting the two actors, weighted networks specify the strength or frequency of interaction and therefore provide a more informed understanding of the social structure. The measure of degree centrality was extended to take into account weighted ties (Barrat et al., 2004; Newman, 2004). In-degree centrality in a weighted network is generally operationalized as:

$C_I^W(i) = \sum_{j=1}^{n} w_{ji}$,

where w is the weighted adjacency matrix. Thus, w_{ji} represents the strength or frequency of the incoming tie from actor *j* to actor *i*. This extension of degree centrality was recently criticized by Opsahl et al. (2010, p. 246), by noting that "node strength is a blunt measure as it only takes into consideration a node's total level of involvement in the network, and not the number of other nodes to which it is connected." In Figure 10 below, Opsahl et al. (2010) show how this can be problematic. In the diagram, Opsahl et al. (2010) note that while node A and node B have the same weighted degree centrality, node B is connected to twice as many actors.

Figure 10: Weighted Degree vs. Number of Total Connections (from Opsahl et al. 2010)



Because the strength of one's connections and one's overall connectedness in the network are both important factors to consider when calculating centrality, Opsahl et al. (2010) developed a tuning parameter, α, that allows the researcher to specify the relative importance of each factor. Using the tuning parameter, in-degree and out-degree centrality can be measured as:

$$C_I^{w\alpha}(i) = k_i^{in} * \left(\frac{s_i^{in}}{k_i^{in}}\right)^{\alpha},$$

$$C_O^{w\alpha}(i) = k_i^{out} * \left(\frac{s_i^{out}}{k_i^{out}}\right)^{\alpha},$$

where k is the number of incoming or outgoing ties and s is the strength of those ties. Given this formalization, a researcher can adjust the tuning parameter to fit his or her theory. When α is set between 0-1, having a high degree adds more to an actor's centrality holding strength constant. When α is above 1, having fewer ties adds more to an actor's centrality score holding strength constant. Consequently, when α is set to 0, the measure is identical to that of Freeman's (1979) binary version, and when α is set to 1, the measure is identical to a simple weighted measure.

The social networks measured in the schools of Finley are believed to be important contributors to teacher level and school level outcomes. Most importantly, connections between teachers are seen as the pathways by which tacit knowledge is spread. Previous research has

indicated that strong ties are more effective at disseminating tacit knowledge (Hansen, 1999), and thus, from a theoretical perspective, a teacher's centrality in the network should favor an individual who has a few strong connections over an individual with many weak connections. Because of this, the tuning parameter was set to 1.5 for calculating a teachers in-degree and out-degree centrality.

The Opsahl et al. (2010) method of calculating centrality with the tuning parameter set to 1.5 was used in both the advice and friendship networks in each of the 21 schools. The variables are in-degree centrality in the advice network (IN_DEGWad), out-degree centrality in the advice network (OUT_DEGWad), in-degree centrality in the friendship network (IN_DEGWf), and out-degree centraity in the friendship network (OUT_DEGWf). Based on these measures, the following hypotheses are offered:

Hypothesis One: (a) Teacher in-degree centrality in the advice network will have a positive and significant effect on efficacy outcomes. (b) Teacher in-degree centrality in the advice network will have a positive and significant effect on commitment outcomes. (c) Teacher in-degree centrality in the friendship network will not have significant effect on efficacy outcomes. (d) Teacher in-degree centrality in the friendship network will have a positive and significant effect on commitment outcomes.

Teachers who maintain a high in-degree centrality in the advice network are focal actors in knowledge dissemination. Fellow teachers actively choose to seek them out for advice because they hold information that coworkers deem as useful for success in schools. Thus, such teachers should hold higher levels of self-efficacy given that peers see them as having the capacity to successfully deal with the task of teaching. Consequently, teachers with higher levels of efficacy also tend to be more committed to the organization (Coladarci, 1992; Ware and

Kitsantas, 2007). Teachers with a high in-degree centrality in the friendship network experience strong social support in the school and hence may be more committed to the organization as well as the profession. However, while such social support may be an important contributor to a teacher's ability to deal with the everyday stress in a school environment, it is hypothesized to have little influence on their cognitive assessment of their capacity to perform well.

Hypothesis Two: (a) Teacher out-degree centrality in the advice network will not have a significant effect on efficacy. (b) Teacher out-degree centrality in the advice network will have a positive effect on commitment. (c) Teacher out-degree centrality in the friendship network will not have a significant effect on efficacy. (d) Teacher out-degree centrality in the friendship network will have a positive effect on commitment outcomes.

Akin to in-degree centrality, teachers who send more friendship ties in a network may benefit from additional social and emotional support in the school leading to greater levels of commitment, but such ties will not increase efficacy. With regards to centrality in the advice network, the impact of advice seeking is unclear. For instance, individuals who seek advice from many of their peers may simply be struggling to perform in the classroom and therefore a high out-degree centrality in the advice network could be a sign of a teacher in need of greater assistance. Alternatively, a high out-degree centrality in the advice network could indicate individuals who understand the benefit of collaboration and seek to implement and build upon the tacit knowledge and experience of their peers. With regard to commitment, a high number of out-degree ties could signal a high degree of trust with one's peers leading to higher levels of commitment.

Principal Centrality: Centrality in an organization's informal communication network affords leaders and managers the ability to enact their interpersonal influence. Balkundi and

Harrison (2006), through their use of meta-analysis, reveal that groups whose leaders were more central in the network tended to be higher performing groups. With regard to school networks, Friedkin and Slater (1994, p. 139) argue that "two features of the schools' social networks appear especially relevant to school effects - the principal's centrality in the school's communication network and the cohesion of the network." Friedkin and Slater go on to say that "it is likely that school principals may effectively coordinate and control instructional activities of their schools only when they have been acknowledged as credible sources of advice on instructional matters" (p. 140).

The measurement of principal centrality can be calculated in a variety of ways. Given the leadership role played by the principal, incoming ties seemed to be the most appropriate measure of principal centrality. Thus, principals with a greater number of incoming ties are seen as instructional leaders by teachers and have a greater ability to influence classroom activities. Supporting this operationalization, Friedkin and Slater (1994) found a positive correlation between a principal's in-degree centrality in the advice network and school performance. The authors found no effect for out-degree centrality, nor any association between principal centrality in the friendship network and school performance. While theory guided the value of the tuning parameter in defining teacher centrality in weighted networks, with regard to the principal's centrality in the school network it is unclear as to whether or not strong ties or more numerous ties should have a more important role in defining principal centrality. Therefore, principal centrality (PRINCIPAL_CENT) was calculated using a simple sum of incoming ties in the weighted advice network and normalized to allow for comparison across schools. Based on this measure,

Hypothesis Three: (a) Teachers who work in schools where the principal is more central in the advice network will have higher levels of teacher efficacy. (b) Teachers who work in schools where the principal is more central in the advice network will have higher levels of teacher commitment.

Network Density: Network density, in non-weighted or binary networks, is simply the proportion of possible ties in a network that are actually present (Wasserman and Faust, 1994). In a weighted network, network density is a measure of the average strength of tie in a network (Wasserman and Faust, 1994). For directed networks the formula for density is:

$$l / n(n\text{-}1),$$

where l is the number of existing ties, and $n(n\text{-}1)$ is the number of possible directed ties among the n actors.

In the Finley School District network ties are weighted from 0-4, thus, if half of the individuals were connected with a strength of 4 and half of the individuals were unconnected (i.e. a strength of zero) then the network density would be 2. Network density was calculated for both the advice network (SCH_DEN_ADSEEK) and the friendship network (SCH_DEN_FRIEND). Because network density captures the level of connectedness among the actors in a network, it can be considered a measure of the cohesiveness of the network. Network cohesion, especially in school communication networks, "provides informal social control, consensus formation, efficient access to material resources, and social support processes (Friedkin and Slater, 1994, p. 141)."

Hypothesis Four: (a) Advice network density will have a positive effect on teacher self-efficacy. (b) Advice network density will have a positive effect on teacher commitment. (c)

Friendship network density will not have a significant effect on self-efficacy. (d) Friendship network density will have a positive effect on teacher commitment.

The dataset used to test these hypotheses and model teacher efficacy and commitment contained 421 observations of teachers nested in 21 schools along with individual and school level variables. The demographic control variables used were gender (SEXM), race (RACE), the number of years a teacher has been working in the district (YRSDIST), and the education level of the teacher (EDUC). Education was measured on a three point scale indicating bachelor, masters, or PhD degree. The demographic characteristics of the teachers in the study are displayed in Table 9 below. Like many school districts, the teachers in Finley are predominantly white and female.

Table 9: Summary of Demographic Statistics

	Mean	St. Dev
YRSDIST	11.76722	10.09894
EDUC	1.730952	0.815421
SEX (Female)	85.70%	
RACE (White)	92.80%	
n=421		

The ten composite survey variables along with the network variables at both the individual and school level were used as predictors of the three efficacy and two commitment outcome variables. Table 10 provides a correlation matrix of these variables.

Table 10: Correlation Matrix of Independent and Dependent Variables[15]

	YRSDIST	EFFIC_CM	EFFIC_SE	EFFIC_IS	SCMT_ORG	SCMT_PROF	INST	TRTE	COLR
YRSDIST									
EFFIC_CM	0.03								
EFFIC_SE	-0.01	0							
EFFIC_IS	0.05	0	-0.01						
SCMT_ORG	0.17***	0.29***	0.32***	0.28***					
SCMT_PROF	-0.28***	0.20***	0.10*	-0.02	0.01				
INST	0.04	0.18***	0.24***	0.13**	0.51***	0.11*			
TRTE	0.09	0.05	0.01	0.18***	0.36***	0.08	0.42***		
COLR	0.12*	0.02	0.19***	0.20***	0.34***	0.06	0.48***	0.64***	
INFL_SCH	0.07	0.09	0.29***	0.08	0.35***	-0.08	0.57***	0.38***	0.48***
INFL_CLS	-0.04	0.09	-0.05	0.07	0.14**	0.05	0.06	0.15**	0.09
INNV	0.17***	0.06	0.19***	0.25***	0.36***	0.06	0.51***	0.59***	0.84***
REFD	-0.08	0.09	0.14**	0.18***	0.30***	0.01	0.16***	0.15**	0.20***
SOCZ	0.21***	0.07	0.16***	0.16**	0.32***	-0.05	0.37***	0.51***	0.57***
COLB_TOG	-0.09	0.14**	0.18***	0.15**	0.29***	0.06	0.29***	0.27***	0.37***
COLB_OBS	0	0.08	0.07	0.12*	0.21***	0.08	0.09	0.18***	0.08
Principal_Cent	0.14**	-0.05	0.21***	0.15**	0.23***	-0.07	0.35***	0.13**	0.33***
InDegWad	0.11*	0.14**	-0.01	0	0.1	0	-0.07	0.07	0.04
OutDegWad	0.02	0.06	0.12*	0.08	0.17***	-0.03	0.07	0.15**	0.22***
Sch_Den_AdSeek	0.19***	-0.03	0.27***	0.15**	0.26***	-0.16***	0.30***	0.17***	0.35***
Sch_Den_Friend	0.10*	0.05	0.21***	0.05	0.24***	-0.18***	0.15**	0.03	0.16**

	INFL_SCH	INFL_CLS	INNV	REFD	SOCZ	COLB_TOG	COLB_OBS	Principal_Cent
INFL_CLS	0							
INNV	0.45***	0.15**						
REFD	0.20***	0.22***	0.27***					
SOCZ	0.36***	0.07	0.64***	-0.01				
COLB_TOG	0.25***	0.09	0.37***	0.44***	0.29***			
COLB_OBS	0.08	0.12*	0.12*	0.21***	0.13**	0		
Principal_Cent	0.36***	-0.30***	0.28***	0.06	0.24***	0.17***	-0.08	

[15] The efficacy variables have no correlation with each other. The same is true of the commitment variables. The zero correlations are a result of the factor analysis procedures that used an orthogonal rotation to define the factors.

IN_DEGWad	-0.08	0.08	0.03	0.1	0.02	0.16***	-0.03	-0.21***
OUT_DEGWad	0.08	0.12*	0.22***	0.28***	0.15**	0.24***	0.18***	-0.13**
Sch_Den_AdSeek	0.37***	-0.35***	0.27***	0.05	0.29***	0.15**	-0.04	0.69***
Sch_Den_Friend	0.17***	-0.17***	0.10*	0.05	0.13**	0.10*	-0.07	0.27***

	IN_DEGWad	**OUT_DEGWad**	**Sch_Den_AdSeek**
OUT_DEGWad	0.20***		
Sch_Den_AdSeek	0.06	0.05	
Sch_Den_Friend	0.18***	0.12*	0.60***

*** - significant at .001 level; **-significant at .01 level; *significant at .05 level

6.1.2 Multilevel Modeling of Efficacy and Commitment

The efficacy scale used in the Teacher Survey produced three distinct factors: (i) efficacy with regard to student engagement, (ii) efficacy with regard to classroom management, and (iii) efficacy with regard to instructional strategies. The commitment scaled produced two factors: (i) commitment to the teaching profession, and (ii) commitment to the school in which one teaches. Each of these five dimensions was modeled through a multilevel model incorporating all teachers in each of the 21 schools. Multilevel modeling, or hierarchical linear modeling, is needed due to the inherent nesting in the dataset. Teachers who work in the same school might have outcomes that are correlated based on the working environment as individual beliefs and attitudes are strongly influenced by social contexts (Hox, 2010). Thus, it is necessary to deal with the potential autocorrelation of error terms within schools, and multilevel modeling is one approach. The models developed in this section are a two-level model, where teachers (level 1) are nested within their respective schools (level 2).

Given that there were ten survey variables and a range of network variables as possible predictors at both level 1 and level 2, and the additional potential for cross-level interaction, a structured model building approach was implemented. Following the guidelines of (Hox, 2010), the predictive models were carried out in five sequential steps (p. 56-68):

Step 1: Analyze a model with no explanatory variables, an intercept only model, to calculate the intraclass correlation coefficient (ICC). The intercept only model is defined as:

$$Y_{ij} = \gamma_{00} + \mu_{0j} + e_{ij},$$

where, γ_{00} is the grand mean of the outcome variable across all schools and individuals, μ_{0j}, is the residual attributed to the group, and e_{ij}, is the residual attributed to the individual. Thus, the ICC is defined as:

$$\frac{\vartheta_{u0}^2}{\sigma_{u0}^2 + \sigma_e^2},$$

and indicates the amount of variation in the outcome variable that can be attributed to differences between groups.

Step 2: Analyze a model with just the level 1 teacher variables and hold the level 1 variable slopes as fixed. The model is defined as:

$$Y_{ij} = \gamma_{00} + \gamma_{p0}\mathrm{X}_{pij} + \mu_{0j} + e_{ij},$$

where X_{pij}, are the p explanatory variables at the teacher level.

Step 3: Add the level 2 school predictors in the model. Such that:

$$Y_{ij} = \gamma_{00} + \gamma_{p0}\mathrm{X}_{pij} + \gamma_{0q}\mathrm{Z}_{qj} + \mu_{0j} + e_{ij},$$

where Z_{qj} are the q explanatory variables at the school level.

Step 4: Determine if any of the level 1 explanatory variables have a significant variation in slope between schools. This model is defined as:

$$Y_{ij} = \gamma_{00} + \gamma_{p0}\mathrm{X}_{pij} + \gamma_{0q}\mathrm{Z}_{qj} + \mu_{pj}\mathrm{X}_{pij} + \mu_{0j} + e_{ij},$$

where the μ_{pj} are the school level residuals of the slopes of the teacher level explanatory variables X_{pij}.

Step 5: Finally, add cross-level interactions between teacher level and school level explanatory variables for the teacher level variables that had significant slope variation between schools. The final model in the building process is defined as:

$$Y_{ij} = \gamma_{00} + \gamma_{10}X_{ij} + \gamma_{01}Z_j + \gamma_{11}X_{ij}Z_j + \mu_{1j}X_{1ij} + \mu_{0j} + e_{ij}.$$

For each of the five outcome variables, and for each type of network, these model building procedures revealed that there were no significant variation in slopes of the level 1 predictors, and hence there are no cross-level interactions. Because there is no significant variation in slopes and only a small variation in intercepts (as will be noted below), the random effects calculated in the multilevel models are not displayed in the results tables. Following the research by other educational network scholars (Moolenaar et al., 2010; Moolenaar and Sleegers, 2010) separate models were run to test the effect of the advice and friendship network independently.

In the following analysis sections, the results tables for each of the five outcome variables contain three different models. While the model building procedures outlined by Hox (2010) were useful in determining slope and intercept variation, it was instructive to generate three distinct models to assess the effect of the network variables. Model 1 estimated the effect of the demographic variables and the ten survey variables. Model 2 estimated the effect of the demographic variables and the network variables. Model 3 estimated the effect of the demographic, survey, and network variables together.

6.1.2.1 Efficacy - Student Engagement

The ICC for student engagement was .106, indicating that roughly 10% of the variation in teacher efficacy with regard to student engagement can be attributed to between school differences. As displayed in Table 11, Model 2 for student engagement revealed that out-degree centrality in both the advice and friendship networks were significant predictors of efficacy, with the advice effect being roughly twice the size of the friendship effect. In addition, teachers in elementary schools have a significantly higher efficacy with regard to student engagement than teachers in high schools and middle schools.

Table 11: Multilevel Modeling Results for the Efficacy-Student Engagement

		Model 1	Model 2		Model 3	
	Fixed Effects		Advice	Friendship	Advice	Friendship
	(Intercept)	0.2517	-0.0618	-0.1752	0.1831	-0.1504
Level 1	SEXM	-0.4821 ***	-0.5117 ***	-0.5392 ***	-0.4613 ***	-0.4650 ***
	RACE	-0.0151	-0.1313	-0.0885	-0.0553	-0.0431
	YRSDIST	-0.0025	-0.0039	-0.0043	-0.0028	-0.0032
	EDUC	-0.0650	-0.0619	-0.0657	-0.0628	-0.0673
	INST	0.1729 ***			0.1664 **	0.1586 **
	TRTE	-0.1999 ***			-0.1927 ***	-0.1938 ***
	COLR	0.0512			0.0306	0.0381
	INFL_SCH	0.1478 ***			0.1333 **	0.1342 **
	INFL_CLS	-0.0289			-0.0050	-0.0031
	REFD	0.0890 *			0.0808	0.0770
	SOCZ	0.0971 *			0.0905	0.0854
	COLB_TOG	0.0592			0.0504	0.0589
	COLB_OBS	0.0484			0.0390	0.0510
	IN_DEG		-0.0025	-0.0024	-0.0026	-0.0015
	OUT_DEG		0.0075 ***	0.0034 *	0.0038	0.0018
Level 2	PRINCIPAL_CENT		-1.5517	3.3702	-4.4743	0.6186
	SCH_DEN		0.1263	0.2073	0.0374	0.3468
	SCH_TYPE		0.5335 **	0.4062 **	0.5253 *	0.2293
	AIC	1137	1178	1182	1157	1160
	BIC	1202	1226	1231	1242	1244
	n	405	419	419	405	405

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

Supporting the conclusion of Tschannen-Moran et al. (1998), Model 3 for friendship and advice showed that the instructional leadership of the principal and decision-making structures in the school were positive and significant predictors. Surprisingly, trust was also a significant predictor but carried a negative coefficient. Thus, holding the level of reflective dialogue, collaboration, and networking (all variables believed to be positively influenced by trust) constant, the higher the level of trust a teacher perceived among his or her colleagues, the lower the teacher's self efficacy concerning student engagement. Once the ten survey variables are controlled for in Model 3, none of the network variables were significant.

Of the seven hypotheses offered regarding efficacy, Model 3 provided support for four of them: 1.C, stating that in-degree centrality in the friendship network would have no effect on efficacy; 2.A, stating that out-degree centrality in the advice network would have no effect on efficacy; 2.C, stating that out-degree centrality in the friendship network would have no effect on efficacy; and 4.C, stating that density in the friendship network would have no effect on efficacy. None of the hypotheses positing a significant relationship between a network variable and student engagement were supported. Neither an individual's centrality in the friendship or advice networks nor the density of those networks in the school had a significant effect on a teachers sense of self efficacy with regard to student engagement.

6.1.2.2 Efficacy - Classroom Management

The ICC of classroom management was nearly half the size of the ICC for student engagement. Only 5.55% of the variation in a teacher's efficacy with regard to classroom management is due to differences at the school level. While this percentage is low, it still justifies the use of multilevel modeling to investigate the effect of teacher and school level

variables. Based on the results in Model 3, shown in Table 12 below, the survey variables that had a significant effect on classroom management efficacy in both the advice and friendship models were the instructional leadership of the principal and the amount of time teachers collaborated together. In the advice model, collective responsibility had a significant negative effect. Indicating that teachers who perceived their coworkers as taking greater responsibility to help each other improve the school felt lower levels of personal self-efficacy. This could be due to the fact that individuals with high perceptions of collective responsibility see student improvement as a school-wide task and thus feel less able to personally influence change. While trust was not a significant predictor in the classroom management model, it still carried a negative coefficient. In-degree centrality in both the friendship and advice networks was found to be a significant predictor.

Table 12: Multilevel Modeling Results for the Efficacy-Classroom Management

		Model 1	Model 2		Model 3	
	Fixed Effects		Advice	Friendship	Advice	Friendship
	(Intercept)	0.1445	-0.0582	-0.0025	0.0923	-0.0768
Level1	SEXM	0.1389	0.0478	-0.0031	0.1622	0.1401
	RACE	-0.3586 *	-0.4063 **	-0.3685 *	-0.3381 *	-0.3185
	YRSDIST	0.0035	-0.0019	-0.0012	0.0024	0.0030
	EDUC	0.0481	0.0554	0.0599	0.0339	0.0339
	INST	0.2389 ***			0.2546 ***	0.2700 ***
	TRTE	-0.0111			-0.0303	-0.0377
	COLR	-0.1456 **			-0.1319 *	-0.1245
	INFL_SCH	0.0170			0.0394	0.0308
	INFL_CLS	0.0325			0.0098	0.0063
	REFD	-0.0038			-0.0078	-0.0123
	SOCZ	0.0362			0.0459	0.0453
	COLB_TOG	0.1686 ***			0.1414 **	0.1440 **
	COLB_OBS	0.0611			0.0649	0.0757
	IN_DEG		0.0113 **	0.0077 *	0.0117 **	0.0106 **
	OUT_DEG		0.0022	-0.0003	0.0002	-0.0014
Level 2	PRINCIPAL_CENT		2.6653	0.4849	0.6271	-2.2744
	SCH_DEN		0.0346	0.1836	-0.1131	0.2963
	SCH_TYPE		-0.2325	-0.1042	-0.1788	-0.1890
	AIC	1199	1236	1238	1217	1214
	BIC	1263	1284	1287	1301	1298
	n	405	419	419	405	405

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

Two of the network predictors had a significant effect, in-degree centrality in the advice network and in-degree centrality in the friendship network. The latter was not hypothesized, but indicates that teachers who receive a lot of friendship ties have a higher sense of classroom management. Michael Linsin, an educator and author of the award-winning book "Dream Class: How To Transform Any Group Of Students Into The Class You've Always Wanted" wrote on his blog that teachers who are pessimistic, impatient, quick to anger, irritable, and overly sensitive, often had poor control of their classrooms (Linsin 2011). The lack of these same characteristics are likely predictive of being central in a friendship network and as noted in the MRQAP models, the Amity Factor was a positive predictor of friendship formation. Thus, teacher personality characteristics may not only influence behavioral decision in the work environment, they may also have implications for how capable teachers are in managing student behavior.

Of the hypotheses tested, Model 3 provided support for four of them. Hypothesis 1.A, stating that in degree centrality in the advice network would have a positive impact on efficacy; 2.A, stating that out-degree centrality in the advice network would have no effect on efficacy; 2.C, stating that out-degree centrality in the friendship network would have no effect on efficacy; and 4.C, stating that density in the friendship network would have no effect on efficacy. The classroom management models provided limited and partial support to the belief that social network activity has an impact on efficacy given that only one of the hypotheses claiming a positive and significant network effect was supported.

6.1.2.3 Efficacy - Instructional Strategies

The ICC for instructional strategy efficacy was only a quarter of the size of the student engagement ICC. The intercept only model indicated that just 2.2% in the variation of teacher efficacy concerning instructional strategies could be attributed to school level differences. Thus, the nesting of teachers in schools does not present a serious concern for autocorrelated error terms, but multilevel modeling was used to maintain consistency with the preceding analysis sections and to control for the small amount of school level variation present in the data.

Model 3 in Table 13 indicates an increased variation between the advice and friendship results than found in either the classroom management or student engagement models. In the advice model for instructional strategies, influence in school-level decision making, reflective dialogue, collaboration, and the density of the advice network all had a significant effect. In the friendship model for instructional strategies, only reflective dialogue was significant.

Table 13: Multilevel Modeling Results for the Efficacy-Instructional Strategies

		Model 1	Model 2		Model 3	
	Fixed Effects		Advice	Friendship	Advice	Friendship
	(Intercept)	-0.3668 *	-0.8481 ***	-0.4675 *	-0.6502 **	-0.3452
Level 1	SEXM	-0.1058	-0.0643	-0.1055	-0.0745	-0.0765
	RACE	0.2480	0.2062	0.2430	0.1969	0.1758
	YRSDIST	-0.0010	-0.0015	-0.0007	-0.0026	-0.0014
	EDUC	0.1055	0.0998	0.0969	0.1097 *	0.1069
	INST	0.0435			0.0072	0.0042
	TRTE	0.0575			0.0768	0.0890
	COLR	0.0832			0.0616	0.0645
	INFL_SCH	-0.0802			-0.1053 *	-0.1017
	INFL_CLS	-0.0019			0.0437	0.0277
	REFD	0.1276 **			0.1133 *	0.1257 **
	SOCZ	0.0750			0.0537	0.0572
	COLB_TOG	0.0247			0.0418	0.0427
	COLB_OBS	0.0729			0.0869 *	0.0764
	IN_DEG		-0.0029	-0.0047	-0.0044	-0.0059
	OUT_DEG		0.0045	0.0038 *	-0.0007	0.0004
Level 2	PRINCIPAL_CENT		4.9239 *	5.0251	3.7382	3.5988
	SCH_DEN		0.4687 *	-0.1088	0.4952 *	0.0969
	SCH_TYPE		-0.3329	0.0941	-0.2858	0.0252
	AIC	1204	1238	1244	1224	1227
	BIC	1268	1286	1292	1308	1311
	n	405	419	419	405	405

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

While discussion of the teacher demographic factors have been avoided, the positive and significant impact of education on instructional strategy efficacy should be mentioned. Teachers who have earned a masters or PhD degree perceive a greater ability to design learning strategies for their students. This aspect of efficacy appears to be the most capable of being learned in a graduate program that is often removed from the day to day experiences of the classroom teacher. On the other hand, classroom management tactics and methods of engaging students in a particular school or on a particular topic may be driven more by tacit knowledge or gained through experience than by academic study.

In Model 3 for advice we also see that overall network density is a significant predictor. Schools with greater levels of teacher interaction tend to have teachers with higher instructional

strategy efficacy. This finding supports much of the literature on social networks in schools revealing that teacher interaction and knowledge sharing increases the pool of ideas on which teachers can draw on and use in their own classrooms.

Four of the seven hypotheses regarding the network variables and efficacy were supported: 1.C, stating that in-degree centrality in the friendship network would have no effect on efficacy; 2.A, stating that out-degree in the advice network would have no effect on efficacy; 2.C, stating that out-degree in the friendship network would have no effect on efficacy; and 4..A, stating that density in the advice network would have a positive effect on efficacy.

6.1.3 Modeling Teacher Commitment

6.1.3.1 Commitment - Profession

The ICC for commitment to the teaching profession was 6.1%. Several of the survey variables proved to be significant predictors of commitment in Model 3 for both advice and friendship: instructional leadership, collective responsibility, influence in school level decision making, and collaboration regarding classroom observations. Unexpectedly, the effect of influence on school level decision making was negative. One potential reason for this finding, is that teachers may have limited time to concern themselves with broader school level decisions. As they are increasingly relied upon to make school decisions regarding the use of discretionary funds, in-service programs, or setting standards, they may begin to feel overwhelmed by the demands of teaching and lose commitment to the profession.

Table 14: Multilevel Modeling Results for Commitment-Profession

		Model 1	Model 2		Model 3	
	Fixed Effects		Advice	Friendship	Advice	Friendship
	(Intercept)	0.6768 ***	0.7492 ***	1.0202 ***	0.9022 ***	1.0686 ***
Level 1	SEXM	-0.1721	-0.2496 **	-0.2431 *	-0.2037	-0.1746
	RACE	-0.2094	-0.2007	-0.1873	-0.1648	-0.1829
	YRSDIST	-0.0213 ***	-0.0204 ***	-0.0206 ***	-0.0202 ***	-0.0209 ***
	EDUC	-0.1321 **	-0.1465 **	-0.1398 **	-0.1343 **	-0.1312 **
	INST	0.2198 ***			0.2299 ***	0.2186 ***
	TRTE	0.0643			0.0534	0.0574
	COLR	0.1190 *			0.1451 **	0.1462 **
	INFL_SCH	-0.1901 ***			-0.1696 ***	-0.1625 ***
	INFL_CLS	-0.0096			-0.0462	-0.0530
	REFD	-0.0514			-0.0390	-0.0228
	SOCZ	-0.1001 *			-0.0868	-0.0695
	COLB_TOG	0.0536			0.0573	0.0413
	COLB_OBS	0.0735			0.0818 *	0.0888 *
	IN_DEG		0.0038	0.0086 **	0.0030	0.0094 **
	OUT_DEG		-0.0010	-0.0057 ***	-0.0037	-0.0070 ***
Level 2	PRINCIPAL_CENT		4.4810	3.0947	2.6014	1.7579
	SCH_DEN		-0.3834	-0.6371 **	-0.3701	-0.5815 **
	SCH_TYPE		-0.1934	-0.0759	-0.2195	-0.1690
	AIC	1166	1193	1184	1186	1175
	BIC	1230	1241	1232	1270	1259
	n	405	418	418	405	405

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

Of the network variables, only Model 3-friendship found any significant effects. In-degree centrality was found to increase commitment to the profession while out-degree centrality had a negative effect on commitment. It is possible that individuals who are more involved in sending friendship ties and actively exploring the social aspects of their work environment are less dedicated to the profession and thus spend more time socializing rather than engaged in constructive dialogue about teaching. The negative effect of the density of the friendship network lends additional support for the belief that an overemphasis on the social aspects of the work environment can be detrimental to employee commitment.

The results lend support to only one of the hypotheses regarding commitment. Hypothesis 1.D, was supported as in-degree centrality in the friendship network had a positive and significant coefficient.

6.1.3.2 Commitment - Organization

Not surprisingly, the ICC on commitment to the organization is the highest of the five outcome variables. Nearly 20% of the variation in a teacher's commitment to the organization he or she works for can be attributed to school level differences. The other four outcome variables are more individual based beliefs that may be less affected by differences in organizational culture or management, but one would expect commitment to the organization to be highly dependent on variation in factors at the school level.

Several of the survey variables were shown to be significant predictors in both the advice and friendship models. These variables are instructional leadership, trust, collective responsibility, influence in the classroom, and collaboration with regard to classroom observations. Additionally, in the friendship model, time spent collaborating with coworkers was also a significant predictor.

Table 15: Multilevel Modeling Results for Commitment-Organization

		Model 1	Model 2		Model 3	
	Fixed Effects		Advice	Friendship	Advice	Friendship
	(Intercept)	0.1436	-0.6163 *	-0.4466	-0.2390	-0.4243 *
Level1	SEXM	-0.1375	-0.1165	-0.2156	-0.0850	-0.1231
	RACE	-0.3338 **	-0.4953 ***	-0.3874 **	-0.3731 **	-0.3474 **
	YRSDIST	0.0123 ***	0.0075	0.0073	0.0106 **	0.0109 **
	EDUC	0.0296	0.0194	0.0269	0.0189	0.0272
	INST	0.3796 ***			0.3761 ***	0.3808 ***
	TRTE	0.1163 **			0.1165 **	0.1137 **
	COLR	-0.1032 *			-0.1172 **	-0.1125 **
	INFL_SCH	0.0043			0.0030	-0.0045
	INFL_CLS	0.0750 *			0.0916 **	0.0960 **
	REFD	0.1705 ***			0.1581 ***	0.1460 ***
	SOCZ	0.0983 **			0.0966 *	0.0782
	COLB_TOG	0.0972 **			0.0704	0.0874 *
	COLB_OBS	0.1126 ***			0.1134 ***	0.1130 ***
	IN_DEG		0.0074 *	-0.0012	0.0069 *	0.0006
	OUT_DEG		0.0105 ***	0.0081 ***	0.0028	0.0039 **
Level 2	PRINCIPAL_CENT		4.8285	6.7048	0.6363	2.1792
	SCH_DEN		0.2302	0.2160	-0.0073	0.4134 *
	SCH_TYPE		0.1217	0.3175	0.2822	0.1885
	AIC	1018	1157	1158	1039	1033
	BIC	1082	1206	1207	1123	1117
	n	405	418	418	405	405

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

The only level 2 variable that had a significant impact on commitment to the organization was the density of the friendship network. Unlike commitment to the profession, density had a positive effect on commitment to the organization. As the number of ties in a school increase, the commitment of the teachers to that school increases as well. Thus, cohesion and a more engaged social environment promote a teacher's dedication to his or her school. This more social environment however, as shown above, had a negative impact on a teacher's dedication to the profession itself. This complex relationship between friendship network formation and different aspects of commitment offers a ripe area for future network research. The findings suggest that teachers like their school because they are socially close with their coworkers and enjoy interacting with them in non-school related activities. While such interaction can increase

commitment to the school based on a positive association with one's peers, it potentially distracts from one's professional goals.

The other network variable with a significant effect was in-degree centrality in the advice network. The more central a teacher was in the advice network the more committed he or she was to the school. Based on the hypotheses offered, the results support three of them: 1.B, stating that in-degree centrality in the advice network would have a positive effect on commitment; 2.D, stating that out-degree in the friendship network would have a positive effect on commitment; and 4.D, stating that friendship density would have a positive effect on commitment.

6.1.4 Summary of Multilevel Models

Overall, there was limited support for the network variable hypotheses. For the hypotheses posed regarding the advice networks having a significant impact on the three efficacy variables and the two organizational variables, there were only three instances of significant effects. One, in the classroom management model, in-degree centrality in the network had a significant effect. Two, in the instructional strategy model, school density was significant. Three, in the commitment to the organization model, in-degree centrality was significant.

For the hypotheses posed regarding the friendship network variables, there were only four instances of significant effects in the direction hypothesized. One, in the classroom management model, in-degree centrality was significant. Two, in the commitment to the profession model, in-degree centrality was significant. Three, in the commitment to the

organization model, school density was significant, and four, in the same model, out-degree centrality was significant.

As will be discussed in the following section, a key reason why the network variables were not more effective predictors of efficacy and commitment is that implicit in the calculation of those variables is the assumption that all ties of the same weight provide the same benefit. Meaning, the coworker to whom a teacher is tied is not considered, rather it is only a matter of one's centrality in the network. Such a strong structuralist assumption overlooks the individual attributes of the alters, and these attributes may be the predominant feature of one's network more so than any structural position or number of connections. The network autocorrelation models in the following section attempt to understand how the efficacy and commitment attitudes held by a teacher's peers influence the attitudes held by that teacher.

The multilevel models provided only a partial understanding of how the survey measures and network factors influenced the five outcome variables. The significant survey factors ($p < .05$) found in the models will be used as predictors in the network autocorrelation models. In addition, all significant level 1 network variables will be included as well. As will be discussed below, because the network autocorrelation models are constructed for each school independently, only a limited number of explanatory variables could be included in the models due to the within school sample sizes. Due to the small number of teacher's with available data, school 19 was dropped from the analysis.

6.2 NETWORK AUTOCORRELATION MODELS

At the end of their extensive review on teacher efficacy, Tschannen-Moran et al. (1998, p. 241) call for future research to assess how teachers' beliefs about teaching are shaped by their peers' beliefs. The previous section attempted to identify a link between a teacher's position in a social network and teacher outcomes with regard to efficacy and commitment. It was hypothesized that teachers who developed stronger ties with their peers, controlling for other teacher level and school level attributes, would tend to have higher levels of self-efficacy and organizational commitment. The multilevel models offered very limited support for this argument. One potential reason for the mixed findings may be due to differences in the alters teachers choose. The multilevel models through the calculation of in-degree and out-degree centrality made an implicit assumption that all ties of equal weight brought equal benefits. In the context of any social setting, this assumption is tenuous at best. Beyond the link between the weighted centrality measures and teacher outcomes, a teacher's perception of his or her own self-efficacy and commitment may be influenced by the level of efficacy and commitment of his or her alters.

The social influence of peer beliefs on one's own beliefs is not captured in the multilevel models. There is no variable that takes into account the attitudes of those one is connected to within the school and thus no way to understand how alters' belief or attitude impact ego's beliefs or attitudes. This is a potential reason why the effects of one's networking were not as large or significant as expected. The assumption that all ties are homogenous and provide the same return may be unwarranted. Actor A could be connected to three peers with high commitment to the teaching profession and actor B could be connected to three peers with low commitment. If the strength of the connections were the same for both actors, then their centrality scores would

be identical, but one would probably not expect each actor to have similar levels of commitment. The process by which an individual's beliefs or actions are shaped by his or her peers is known as social influence or contagion.

In order to measure and estimate the social influence of alters' belief on ego, a class of models known as network autocorrelation models can be used. These models are predicated on the belief that individuals connected within a social network transmit interpersonal influence on one another (Marsden and Friedkin, 1993). For an overview and discussion of these models see Doreian et al. (1984), Leenders (2002), and Marsden and Friedkin (1993). In general, an actor is influenced by an alter based on the strength of their relationship. Because, for each teacher in the district, we know the strength of their advice and friendship connections as well as their efficacy and commitment beliefs/attitudes, we can determine the weighted influence of a teacher's social connections.

As discussed by Leenders (2002), let y be a (g x 1) vector of values on the response variable, and let W be a (g x g) matrix indicating the existence and strength of the social ties among the g actors in the network. Each row in the W matrix comprises the frame of reference for actor i, and the alters in that frame of reference ultimately exert some influence on the value of y_i. Each alter carries a weighted influence based on the strength of the tie to the actor. Thus, the W_{ij} cell indicates the influence actor j has on actor i, such that:

$$y_i = \rho W_{i1} y_1 + \rho W_{i2} y_2 + \ ... + \rho W_{ig} y_g + \varepsilon_i.$$

In developing network autocorrelation models for each of the 21 schools in the Finley School District three important design decisions were made. First, the autocorrelation process can be modeled as occurring either through the dependent variable (i.e. the belief or attitude of interest) itself or through the disturbance term (Leenders, 2002). Leenders (2002) states that an

actor may form a belief based on his or her own intrinsic values as well as based on the beliefs of his or her alters. In this example, the focal actor's intrinsic beliefs begin to change due to the influence of peer beliefs. Alternatively, an actor may once again set beliefs based on intrinsic values, but observes how his or her alters deviate from their intrinsic beliefs. Thus, a teacher may observe his or her alters to have a lower level of organizational commitment than their education and number of years in the district would indicate. Based on this deviation, ego may begin to adjust his or her intrinsic views accordingly.

Because teachers are assumed to have a direct effect on one another's attitudes and beliefs, the influence process is modeled through the dependent variable. Such a process, using matrix notation, is modeled as:

$$y = \rho_1 W_1 y + \chi\beta + \varepsilon,$$

where y, is an *n*-vector of attitudes or beliefs believed to be socially influenced, ρ is a measure of the endogeniety of the response variable, W is an *n* x *n* matrix of social connections, χ is an *n* x *m* matrix of the *m* exogenous covariates, β captures the effect of the covariates on the response variable, and ε is a *n*-vector of normally distributed error terms. Because the response variable y, shows up on both sides of the equation, the model cannot be estimated using standard OLS techniques and therefore maximum likelihood is the preferred estimation technique (Doreian et al., 1984; Leenders, 2002; Marsden and Friedkin, 1993).

The second decision concerned the specification of the W matrix, known as the weight matrix, that indicates the structure in the network influencing the spread of beliefs or attitudes. The process of influence is assumed to operate through direct connection in the advice or friendship network. Based on these direct connections, one could specify the weight matrix by simply using the raw network data, that is, keeping the data in its original format indicating the

strength of tie each actor has with every other actor. An alternative approach, and the one employed here, is to row normalize the raw network data such that each cell specifies the relative importance of each actor with regard to the total social influence on ego. For example if actor A has 5 ties, and 4 are of strength 1 and 1 is of strength 4, then the tie of strength 4 has a value of .5, indicating it constitutes fifty percent of the potential influence on ego. Because the network is row normalized, the larger the number of connections, the smaller the influence of any individual connection.

The final decision concerned the covariates to be included in the χ matrix. Because the social influence models are designed for a single network, the total number of exogenous variables that could be included was limited due to the small sample size in some of the elementary schools. Therefore, only the significant predictors from the multilevel models were used as control variables to better estimate the ρ parameters. As the network autocorrelation models are specified for each school, the two demographic variables of gender and race were not included in any of the models due to the lack of variation in some of the schools. In addition, unlike the multilevel models which developed separate equations for advice and friendship, in the network autocorrelation models both the advice and friendship network were included simultaneously. The reason for including the weight matrix for both advice and friendship was to understand which social relation exerted greater influence on one's efficacy and commitment when jointly considered.

An additional network variable was included in the network autocorrelation models. The correlation between each teacher's advice network and friendship network was calculated. This variable captures the extent to which teachers hold multiplex versus uniplex ties. Multiplex relations occur when individuals are connected by more than one type of tie. In the current

context, teachers with multiplex relations hold both a friendship and an advice tie with an alter and thus instrumental support and social support can be derived through the same link. Multiplex relations are considered important structures in networks as multiplexity is often viewed as a measure of tie strength and stability (Provan et al., 2007), and has been predictive of performance (Ingram and Roberts, 2000; Jehn and Shah, 1997; Provan et al., 2009).

In total, five different models will be built for each school - three efficacy models and two commitment models, generating 100 different network autocorrelation models. The outcome variables are the same as those used in the multilevel models.

Given the preceding description, the following two hypotheses are offered:

Hypothesis One: The ρ parameter will be positive and significant for the advice networks.

Hypothesis Two: The ρ parameter will be positive and significant for the friendship networks.

Hypothesis Three: The parameter estimate for network correlation will be positive and significant.

The results for each of the five outcome variables will be discussed briefly. A more in-depth discussion will occur in the meta-analysis section that follows.

6.2.1 Network Effects on Self Efficacy

6.2.1.1 Efficacy - Student Engagement

Based on the multilevel models built in section 6.1, the primary factors influencing a teacher's sense of self-efficacy with regard to student engagement were instructional leadership (INST), trust (TRTE), and influence in school decision-making (INFL_SCH). These three variables plus the network correlation variable (NET_COR) and the two ρ parameters, one for

the advice network and one for the friendship network, were included in the model. Hence, one's student engagement-efficacy is a function of (i) one's perception of instructional leadership, trust, and influence in school decision-making, (ii) the correlation between one's advice and friendship networks, and (iii) the student engagement-efficacy of his or her advice and friendship connections.

$$y_{SE} = \rho_1 W_1 y_{SE} + \rho_2 W_2 y_{SE} + \beta_1 INST + \beta_2 TRTE + \beta_3 INFL\_SCH + \beta_4 NET\_COR + \epsilon$$

Because the ρ parameters and coefficient on network correlation are the primary focus of this section and the fact that the significance of the survey variables (INST, TRTE, INFL_SCH) were discussed previously in the multilevel modeling section, only the results for network effects and network correlation will be displayed (i.e. $\rho_1,\ \rho_2, \beta_4$).

Table 16 below shows the results of the analysis in each of the 20 schools. The results will be aggregated and discussed in the meta-analysis section.

Table 16: Summary Results for Efficacy-Student Engagement Network Autocorrelation Model

School	Advice ρ	Pr(>|z|)	Friend ρ	Pr(>|z|)	Network Correlation β	Pr(>|z|)
1	0.0762	0.8441	0.5562	0.1489	-1.0109	0.0647
2	1.1940	0.0867	-1.5302	0.0117	0.6563	0.1375
3	2.8842	0.0000	-0.4695	0.2306	-0.1942	0.7617
4	-1.1975	0.0472	0.4020	0.5083	0.2959	0.6649
5	-0.0797	0.8694	-0.1929	0.6623	-0.7756	0.1265
6	0.1998	0.7830	-1.1931	0.1460	-0.3048	0.6869
7	-0.0559	0.9395	-0.3200	0.5847	0.1279	0.8311
8	-0.7059	0.0261	-1.0144	0.0001	0.5195	0.2466
9	0.1904	0.8404	-0.1568	0.8669	0.7384	0.4461
10	2.5854	0.0000	0.7619	0.0867	0.6215	0.3960
11	0.2430	0.4665	0.2386	0.5218	-0.2900	0.6087
12	-0.0181	0.9749	-1.2880	0.0093	2.0227	0.0005
13	0.5810	0.5047	-0.5161	0.5297	-0.2569	0.7694
14	0.3896	0.5013	-0.0835	0.7868	-0.3529	0.6038
15	-0.6121	0.4460	0.3035	0.7528	0.1886	0.7923
16	0.9368	0.1234	-0.8629	0.0513	2.0847	0.0206
17	0.7696	0.1967	-1.5413	0.3770	2.6489	0.0244
18	0.6911	0.3372	-0.8939	0.1773	-0.1466	0.8861
19	1.0235	0.0196	-0.8754	0.1485	0.9788	0.0896
20	0.8719	0.0553	-0.8885	0.0606	0.7306	0.2498

Graphically, the results of the model are shown in a forest plot in Figures 11, 12, and 13. The first plot displays the ρ parameters for the advice network, the second plot displays the ρ parameters for the friendship network, and the third plot displays the coefficient on network correlation. In each of the plots, the vertical dashed line is centered over zero (i.e. no effect).

Figure 11: Forest Plot of Advice ρ for Efficacy in Student Engagement

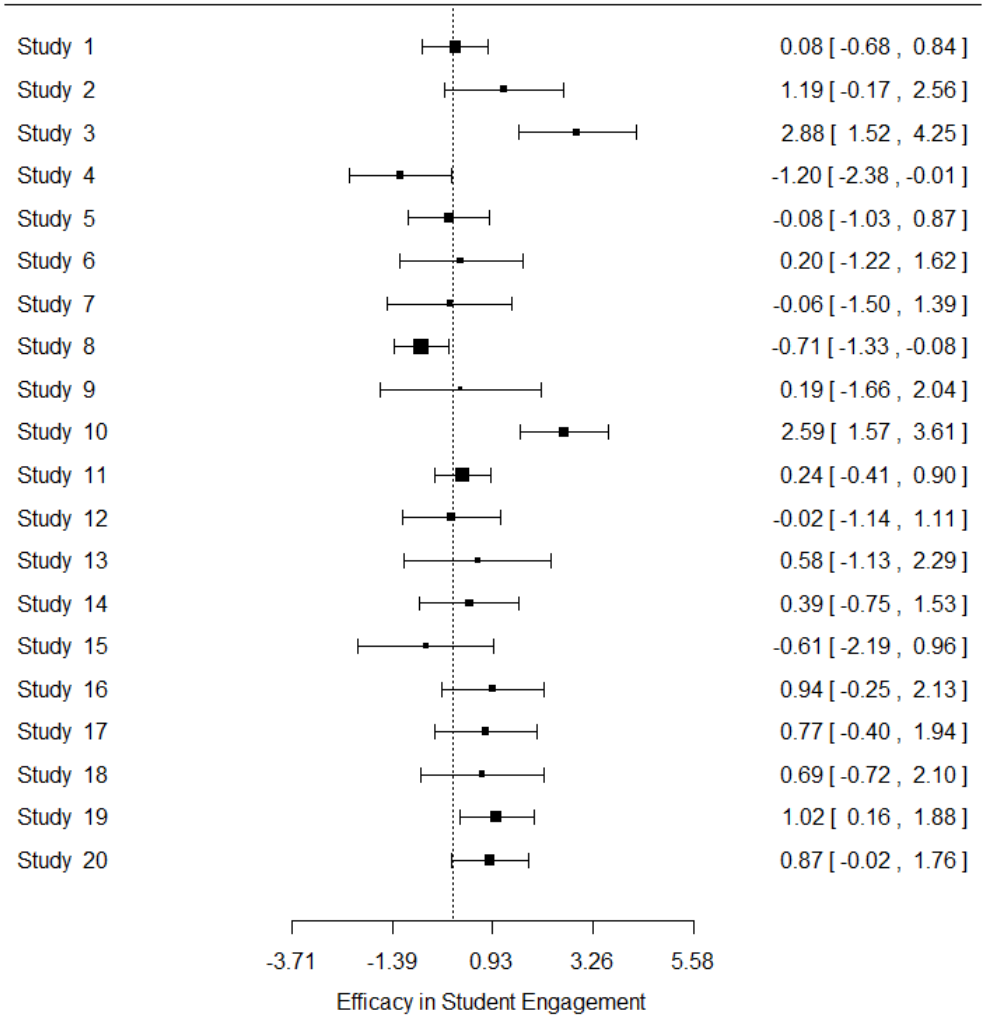


Figure 12: Forest Plot of Friendship ρ for Efficacy in Student Engagement

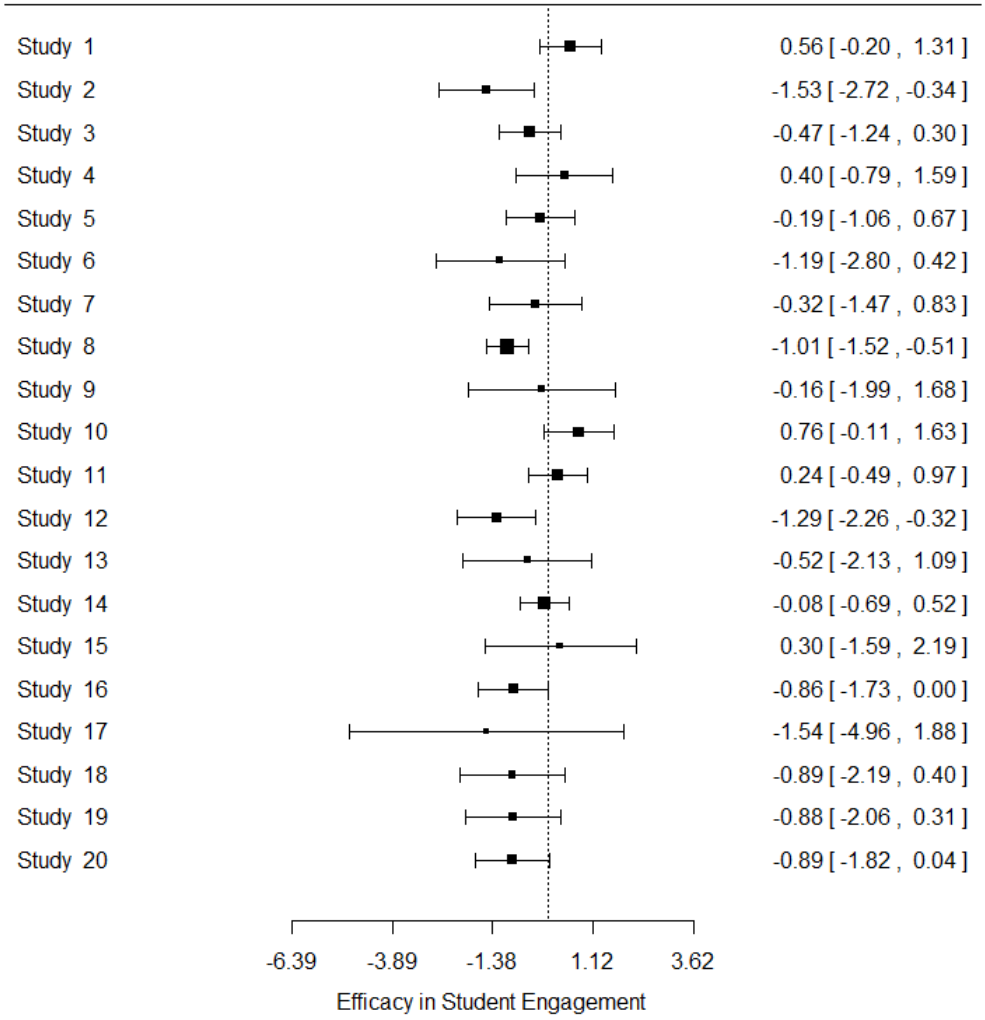
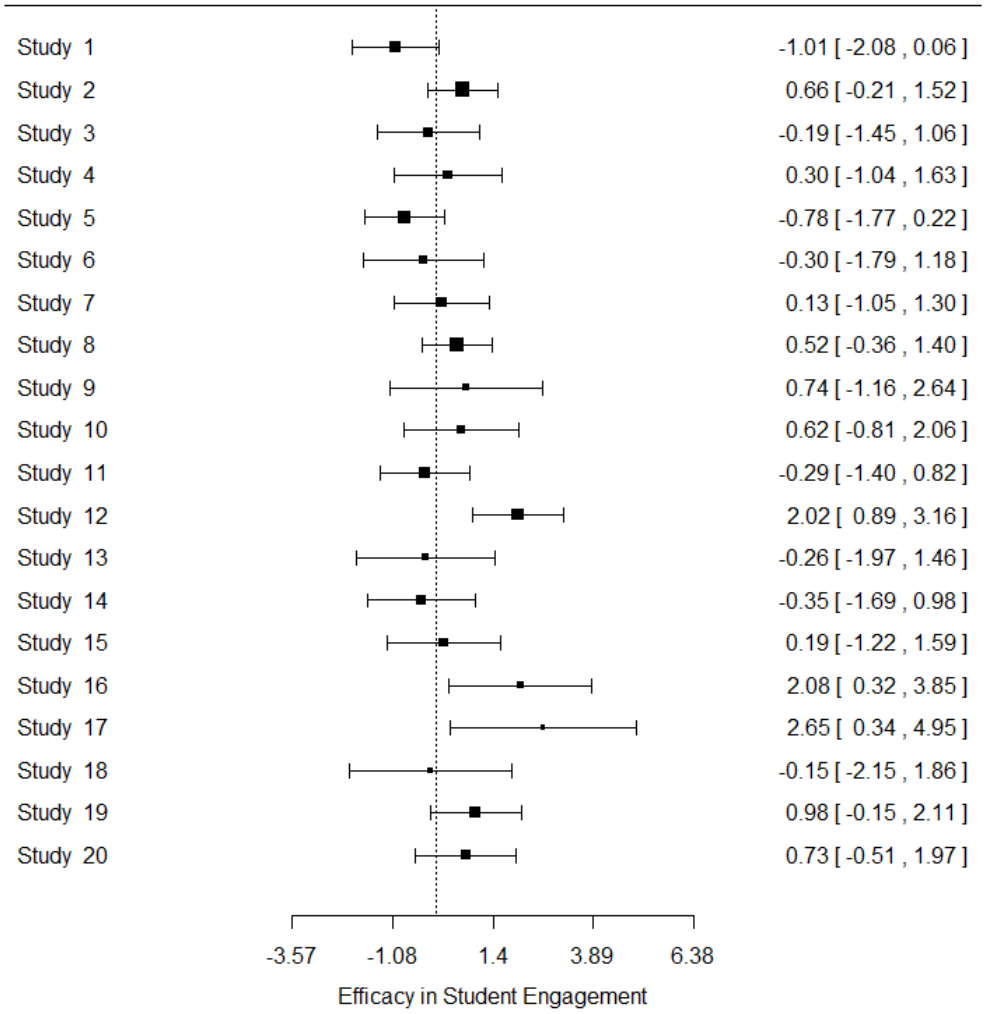


Figure 13: Forest Plot of Network Correlation β for Efficacy in Student Engagement



6.2.1.2 Efficacy - Classroom Management

The multilevel models revealed that the primary factors influencing a teacher's sense of self-efficacy with regard to classroom management were instructional leadership (INST), collaboration on teaching strategies (COLB_TOG), in-degree centrality in the advice network (INDEG_AD), and in-degree centrality in the friendship network (INDEG_F). These four variables along with the network correlation term and the two ρ parameters were included in the

model. Forest plots for the ρ parameters and network correlation β are displayed in Figures 14, 15, and 16 below.

$$y_{CM} = \rho_1 W_1 y_{CM} + \rho_2 W_2 y_{CM} + \beta_1 INST + \beta_2 COLB\_TOG + \beta_3 INDEG\_AD + \beta_4 INDEG\_F + \beta_5 NET\_COR + \epsilon$$

Table 17: Summary Results for Efficacy-Classroom Management Network Autocorrelation Model

School	Advice ρ	Pr(>|z|)	Friend ρ	Pr(>|z|)	Network Correlation β	Pr(>|z|)
1	1.5716	0.0000	0.1098	0.7987	0.4562	0.2714
2	-0.6801	0.0688	1.4027	0.0000	-0.2864	0.6138
3	-1.4273	0.1871	-0.3611	0.6339	-0.4671	0.5847
4	-0.2287	0.5638	-1.7018	0.0000	0.4377	0.3814
5	-0.3648	0.3524	0.2146	0.5997	-1.0269	0.0635
6	0.3935	0.2188	1.0501	0.0017	-2.0708	0.0000
7	-0.3077	0.5588	1.0739	0.0185	-0.3156	0.6084
8	-0.2338	0.5348	0.3008	0.4935	-0.6433	0.5157
9	0.3177	0.2566	-1.3093	0.0000	0.5204	0.3377
10	0.4886	0.4456	-0.4873	0.4444	-1.4837	0.0613
11	0.0186	0.9505	0.4332	0.2798	-0.2934	0.5488
12	-0.5053	0.4174	0.7128	0.3170	1.3370	0.1293
13	-1.0485	0.2999	0.4699	0.4274	2.0695	0.0019
14	-1.4548	0.0449	0.3883	0.4337	-0.8555	0.1556
15	-0.4619	0.5918	-0.7602	0.3794	0.6757	0.3064
16	1.1129	0.1259	-1.7748	0.0000	0.0157	0.9881
17	0.7797	0.3939	-4.2891	0.0204	0.2037	0.8877
18	-0.4074	0.5908	0.5997	0.3447	0.1104	0.9273
19	0.4124	0.4172	-0.5537	0.4207	0.2120	0.7571
20	0.6459	0.2256	-0.4598	0.5477	-0.0195	0.9771

Figure 14: Forest Plot of Advice ρ for Efficacy in Classroom Management

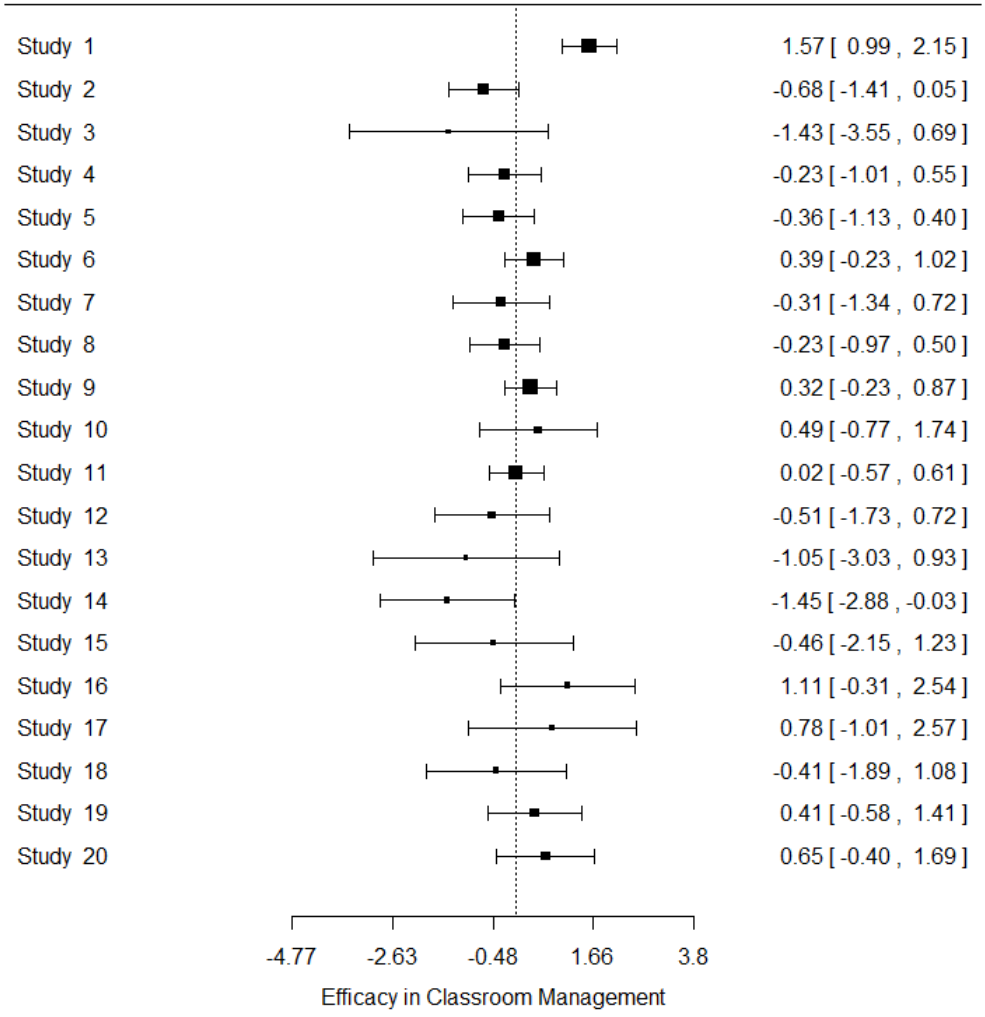


Figure 15: Forest Plot of Friendship ρ for Efficacy in Classroom Management

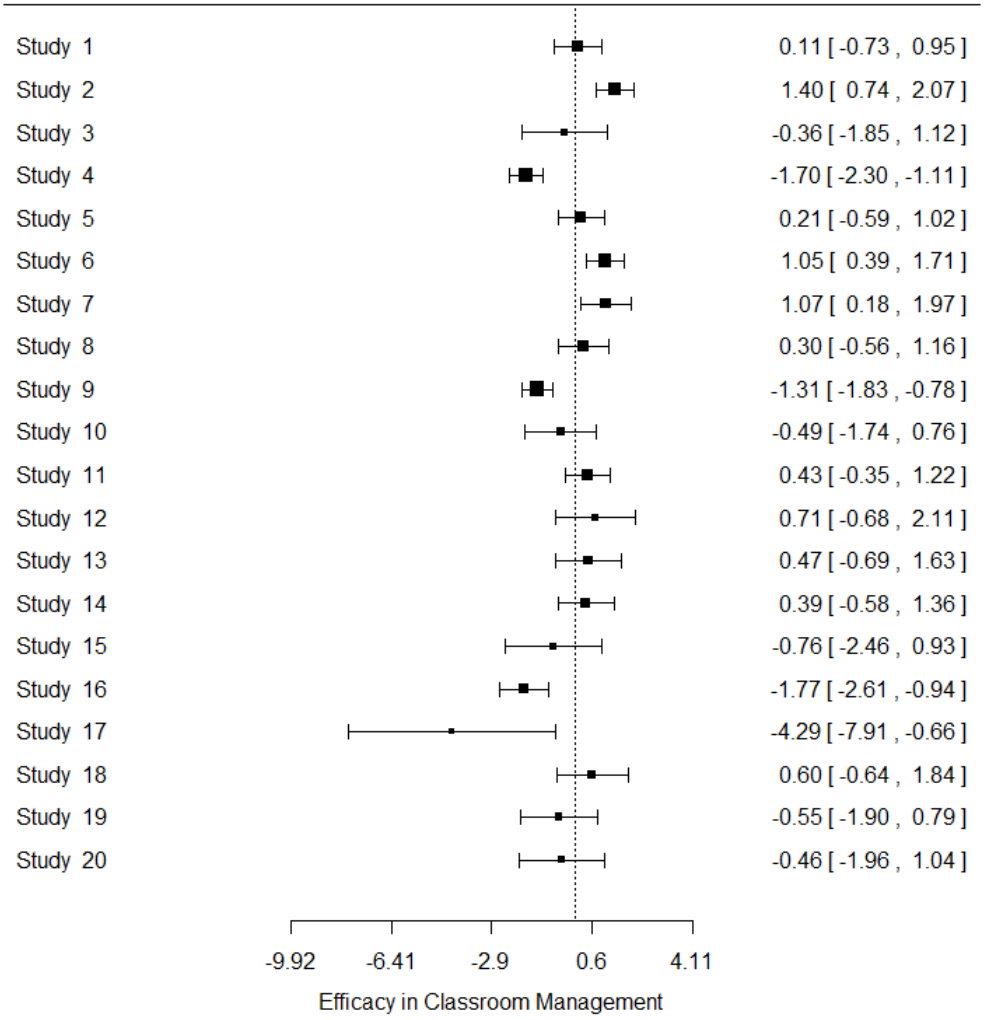
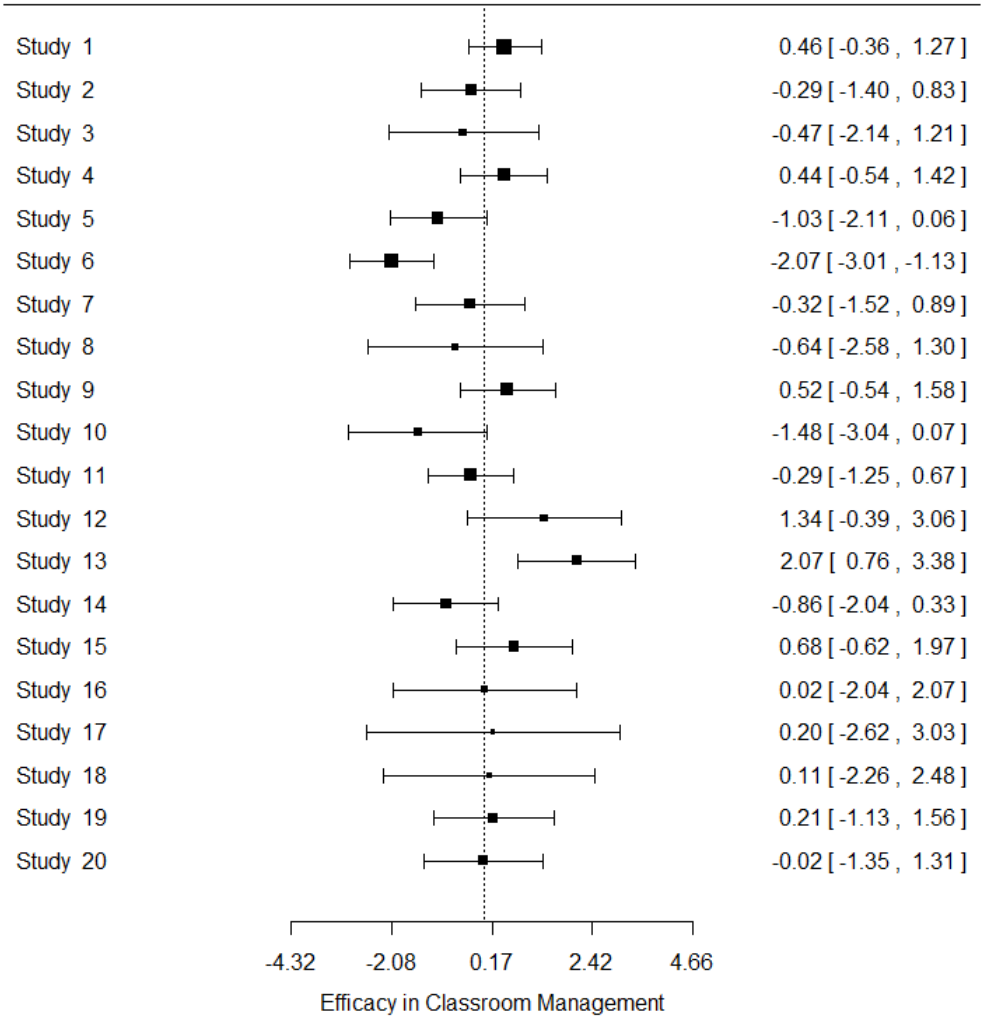


Figure 16: Forest Plot of Network Correlation β for Efficacy in Classroom Management



6.2.1.3 Efficacy - Instructional Strategies

Based on the multilevel models the primary factors[16] influencing a teacher's sense of self-efficacy with regard to instructional strategies were influence in school decision-making (INFL_SCH), reflective dialogue (REFD), collaboration on teaching strategies (COLB_TOG), and education level (EDUC). These four variables along with the two ρ parameters and the

[16] Because only one survey variable was a significant predictor ($p < .05$), the two other survey variables significant at the .10 level were included in the model as well.

network correlation term were included in the model. Table 18 below contains the summary results for the 20 schools which are displayed graphically in Figures 17, 18, and 19.

$$y_{IS} = \rho_1 W_1 y_{IS} + \rho_2 W_2 y_{IS} + \beta_1 INFL\_SCH + \beta_2 REFD + \beta_3 COLB_{TOG} + \beta_4 EDUC + \beta_5 NET\_COR + \epsilon$$

Table 18: Summary Results for Efficacy-Instructional Strategy Network Autocorrelation Models

School	Advice ρ	Pr(>|z|)	Friend ρ	Pr(>|z|)	Network Correlation β	Pr(>|z|)
1	-0.1964	0.8089	0.1525	0.8088	0.2200	0.7737
2	0.4882	0.5202	-0.1487	0.8344	1.2021	0.3584
3	-1.1456	0.1015	-0.7897	0.0183	1.0876	0.0114
4	-0.3535	0.6843	-0.0749	0.9168	-0.7446	0.4104
5	-0.7021	0.0333	0.6975	0.0284	0.1931	0.7281
6	-1.2945	0.0230	-0.4332	0.5326	-0.2607	0.6534
7	1.1074	0.0593	-1.1689	0.0079	1.9345	0.0003
8	0.3217	0.6107	-0.6891	0.1549	1.1280	0.0380
9	0.2889	0.6568	-0.7812	0.1448	0.3099	0.6903
10	-0.2497	0.6372	0.6782	0.2205	1.7820	0.0257
11	-0.0283	0.9390	-0.0186	0.9690	-1.1828	0.0892
12	-0.2221	0.7379	0.7994	0.3171	1.6616	0.0170
13	-0.8353	0.5265	0.0703	0.9447	-0.4914	0.6316
14	0.0706	0.8773	0.4907	0.1888	-0.4612	0.3428
15	3.8233	0.0000	-7.8720	0.0000	2.1537	0.0000
16	-1.2485	0.0138	1.0930	0.0090	1.3040	0.2540
17	0.7402	0.1359	-0.6688	0.3021	1.4525	0.0937
18	-1.1846	0.0199	0.1033	0.8483	0.8523	0.4779
19	0.6318	0.1595	-0.2391	0.6776	0.0940	0.8989
20	-0.1726	0.7084	-0.2482	0.7432	-0.2275	0.7942

Figure 17: Forest Plot of Advice ρ for Efficacy in Instructional Strategies

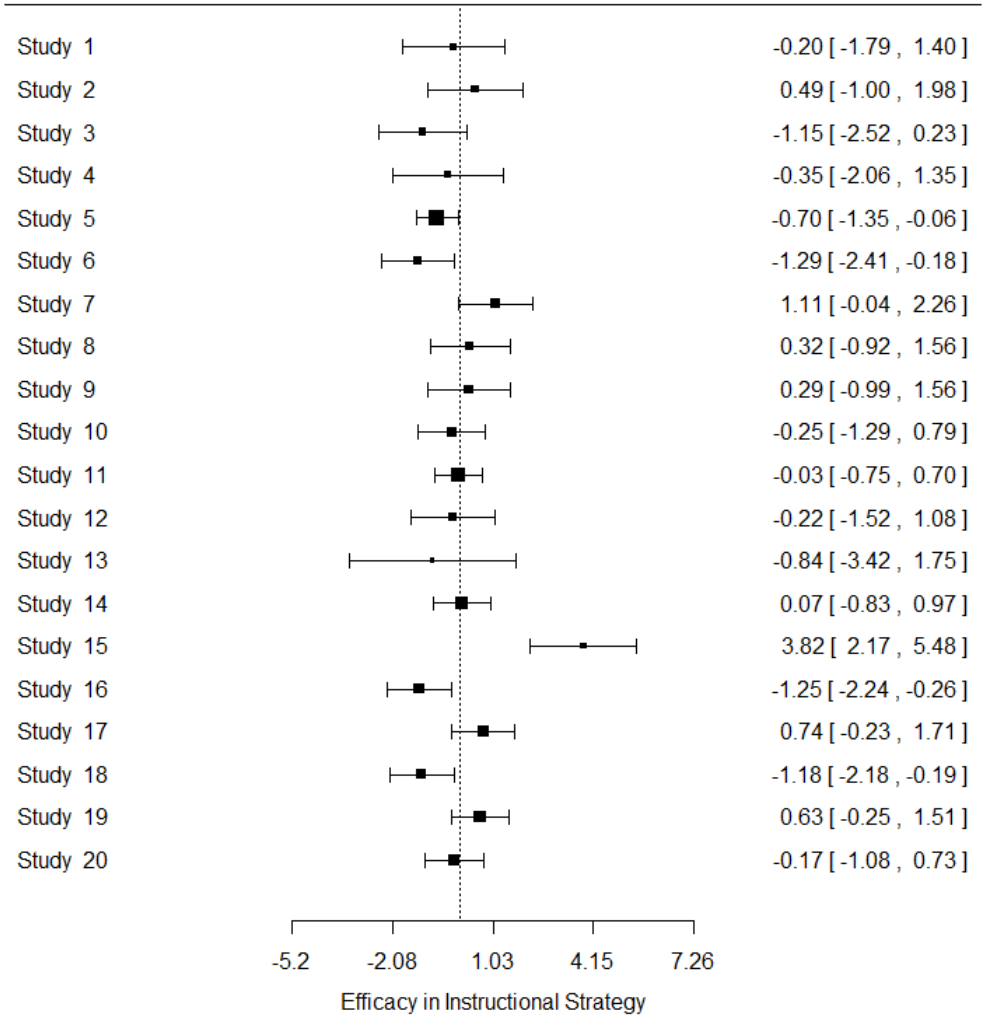


Figure 18: Forest Plot of Friendship ρ for Efficacy in Instructional Strategies

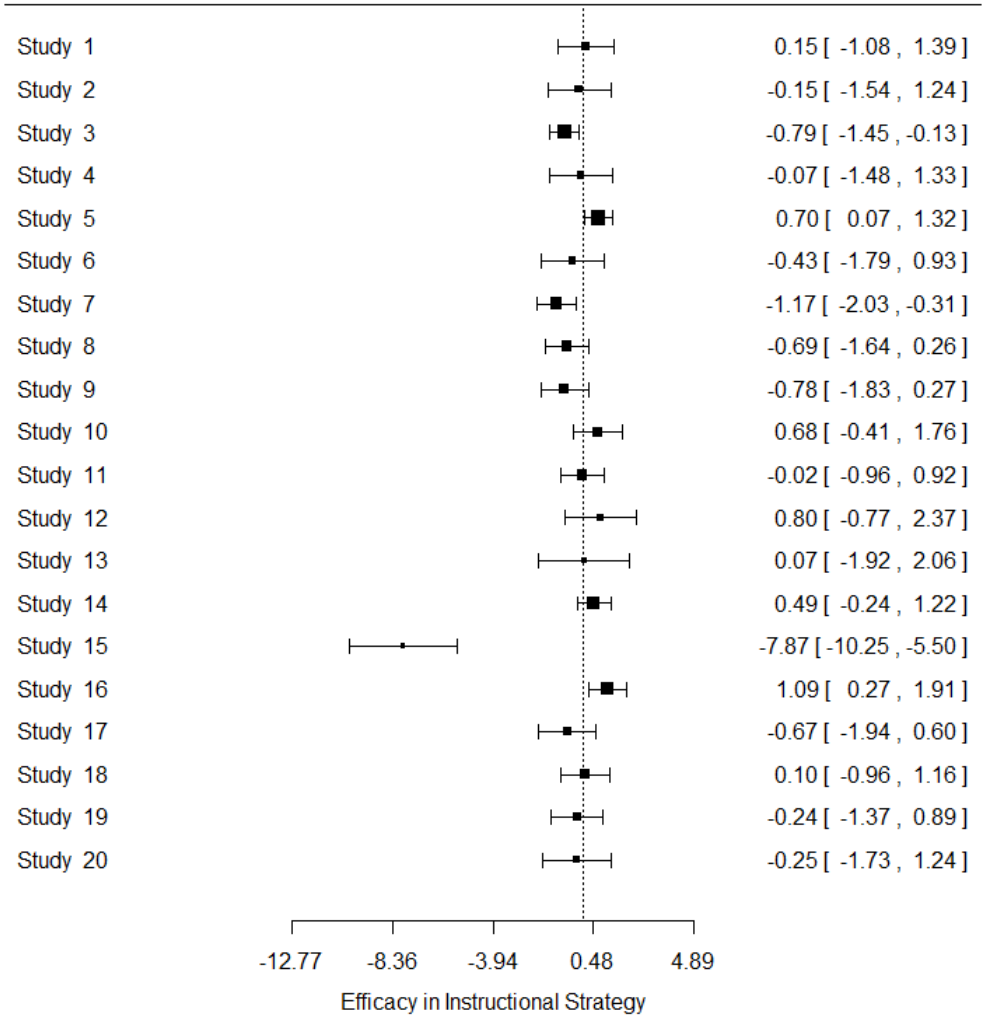
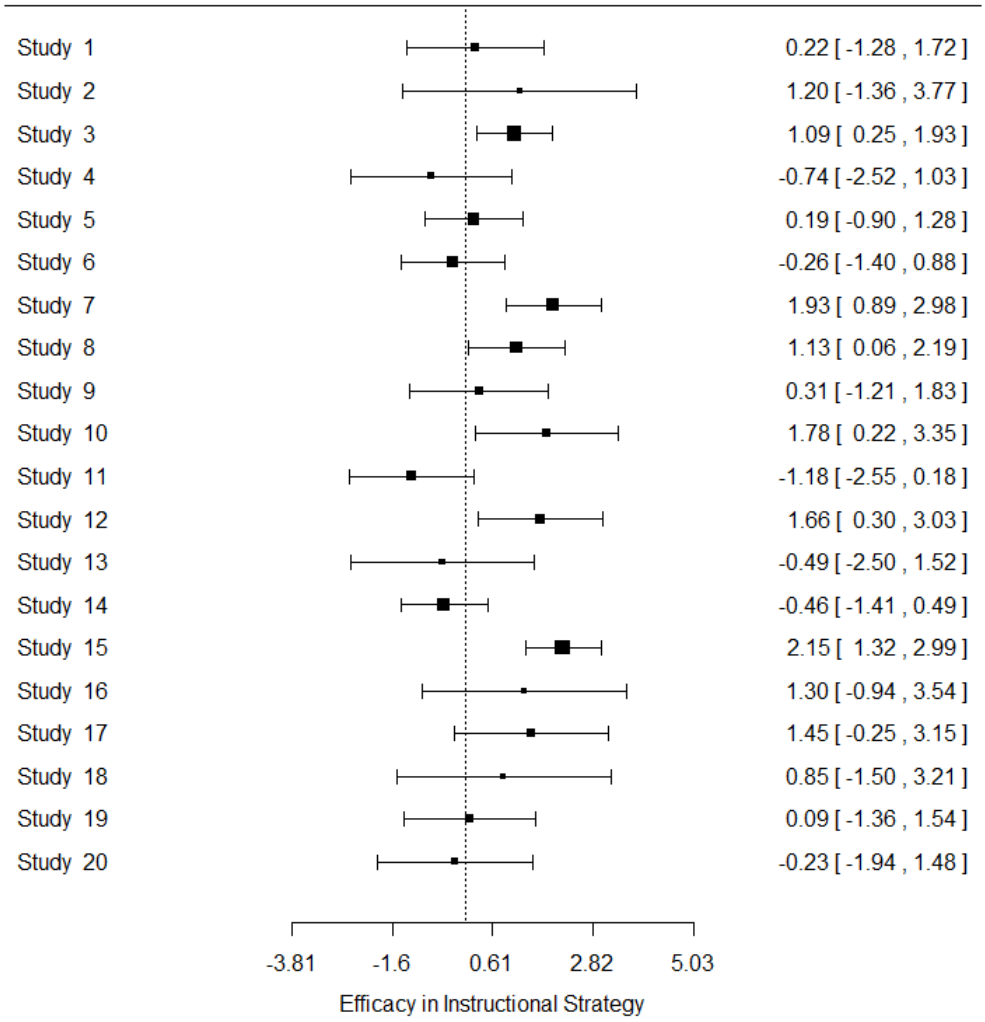


Figure 19: Forest Plot of Network Correlation β for Efficacy in Instructional Strategies



6.2.2 Network Effects on Commitment

6.2.2.1 Commitment - Profession

The primary factors influencing a teacher's commitment to the profession of teaching in the multilevel models were one's perception of instructional leadership (INST), influence in school decision-making (INFL_SCH), the number of years teaching in the district (YRSDIST),

in-degree centrality in friendship network (INDEG_F), and out-degree centrality in the friendship network (OUTDEG_F).[17] These five variables along with the two ρ parameters were included in the model. Table 19 and Figures 20, 21, and 22 display the results of the professional commitment network autocorrelation models.

$$y_{Prof} = \rho_1 W_1 y_{Prof} + \rho_2 W_2 y_{Prof} + \beta_1 INST + \beta_2 INFL\_SCH + \beta_3 YRSDIST + \beta_4 INDEG\_F + \beta_5 OUTDEG\_F + \beta_6 NET\_COR + \epsilon$$

Table 19: Results for Commitment-Profession Network Autocorrelation Models

School	Advice ρ	Pr(>|z|)	Friend ρ	Pr(>|z|)	Network Correlation β	Pr(>|z|)
1	-0.6012	0.2787	0.3768	0.2205	-1.2399	0.0926
2	-2.9145	0.0000	0.3345	0.2475	1.0687	0.0000
3	0.1992	0.6874	0.5580	0.2806	1.2539	0.2153
4	0.8579	0.1274	-1.5731	0.0013	-1.7928	0.0275
5	-0.4141	0.3080	-0.2486	0.6155	-0.5970	0.1785
6	-1.7447	0.0181	1.6897	0.0940	-0.8243	0.1860
7	-3.3327	0.0000	2.0165	0.0002	1.4864	0.0000
8	-0.4378	0.2736	-0.9117	0.0106	-0.9937	0.2133
9	-0.1801	0.8223	0.4541	0.5763	0.3579	0.8087
10	0.2679	0.7348	-0.4608	0.5327	0.0546	0.9451
11	0.2155	0.6678	-0.5472	0.3979	0.0963	0.7727
12	-0.1671	0.8354	0.7881	0.3785	0.1839	0.8317
13	-0.6331	0.5993	-0.0372	0.9693	0.4892	0.6233
14	-0.5119	0.3027	0.6281	0.1060	1.1319	0.0248
15	-0.6441	0.3199	0.1438	0.7891	0.1551	0.7217
16	-1.5903	0.0166	0.8696	0.1106	-0.2210	0.7063
17	-1.8837	0.1567	4.1371	0.1791	-4.5769	0.1692
18	0.4030	0.5904	-0.8110	0.3454	-0.1855	0.8651
19	-0.7187	0.1543	-0.6367	0.2155	-0.3327	0.6074
20	0.0553	0.8748	-0.5137	0.2329	0.1493	0.7402

[17] Other variables were found to be significant in the multi-level models but were not included in the network autocorrelation models due to the small sample size in some of the schools. Therefore, the survey variables that were significant at the .01 level and both the significant network variables were chosen for inclusion.

Figure 20: Forest Plot of Advice ρ for Commitment to the Teaching Profession

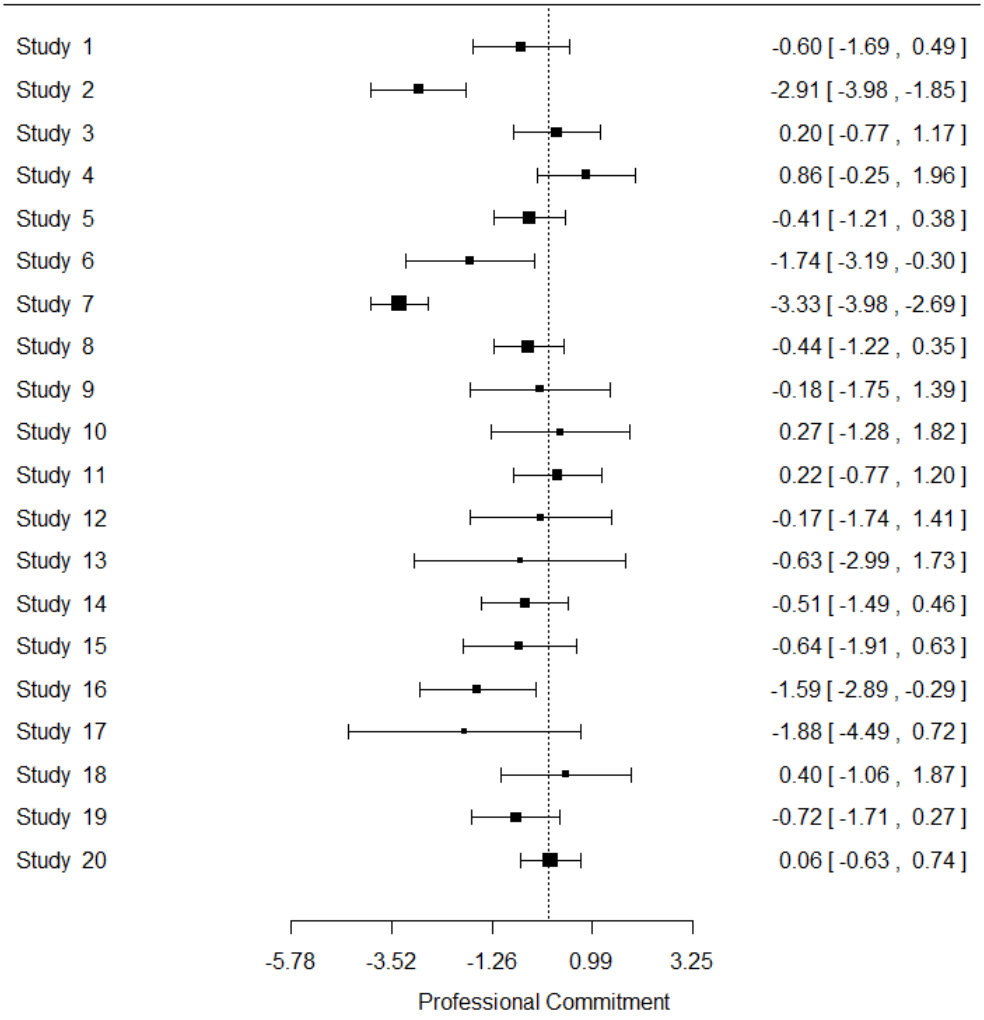


Figure 21: Forest Plot of Friendship ρ for Commitment to the Teaching Profession

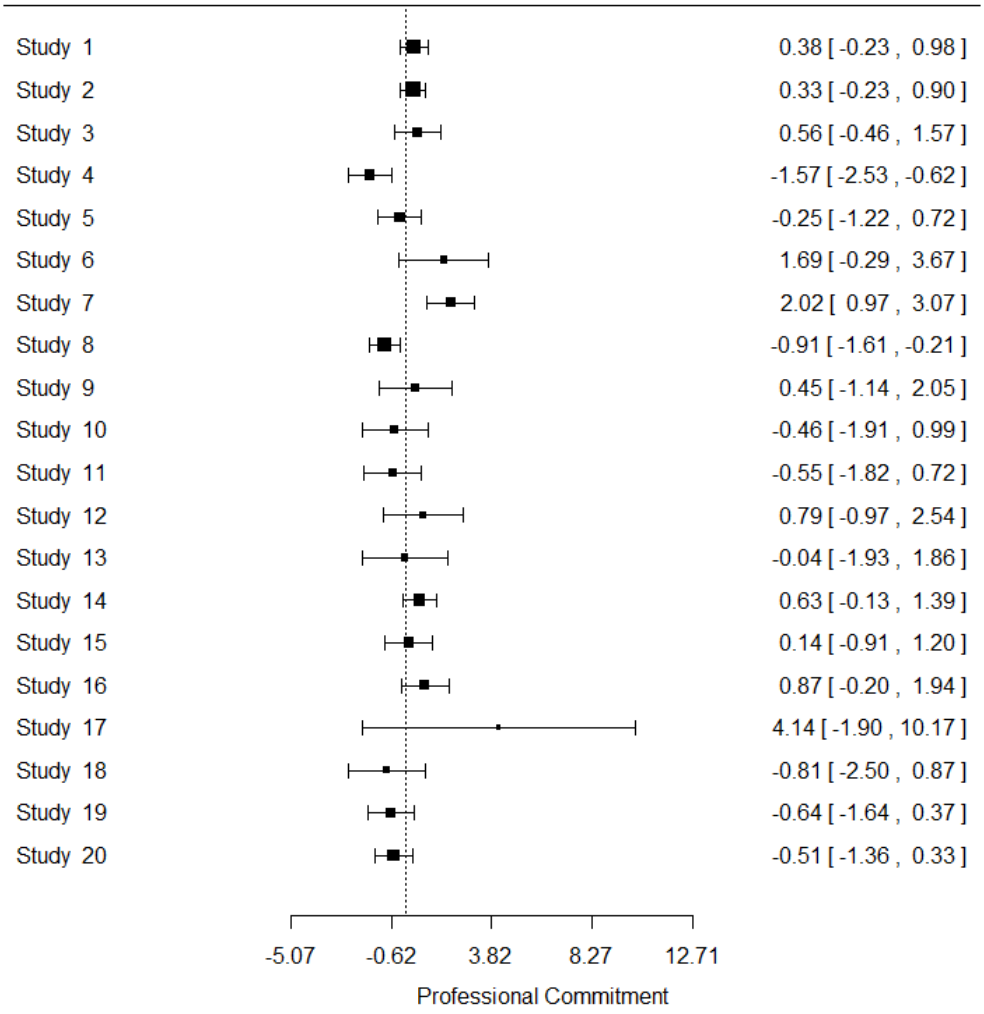
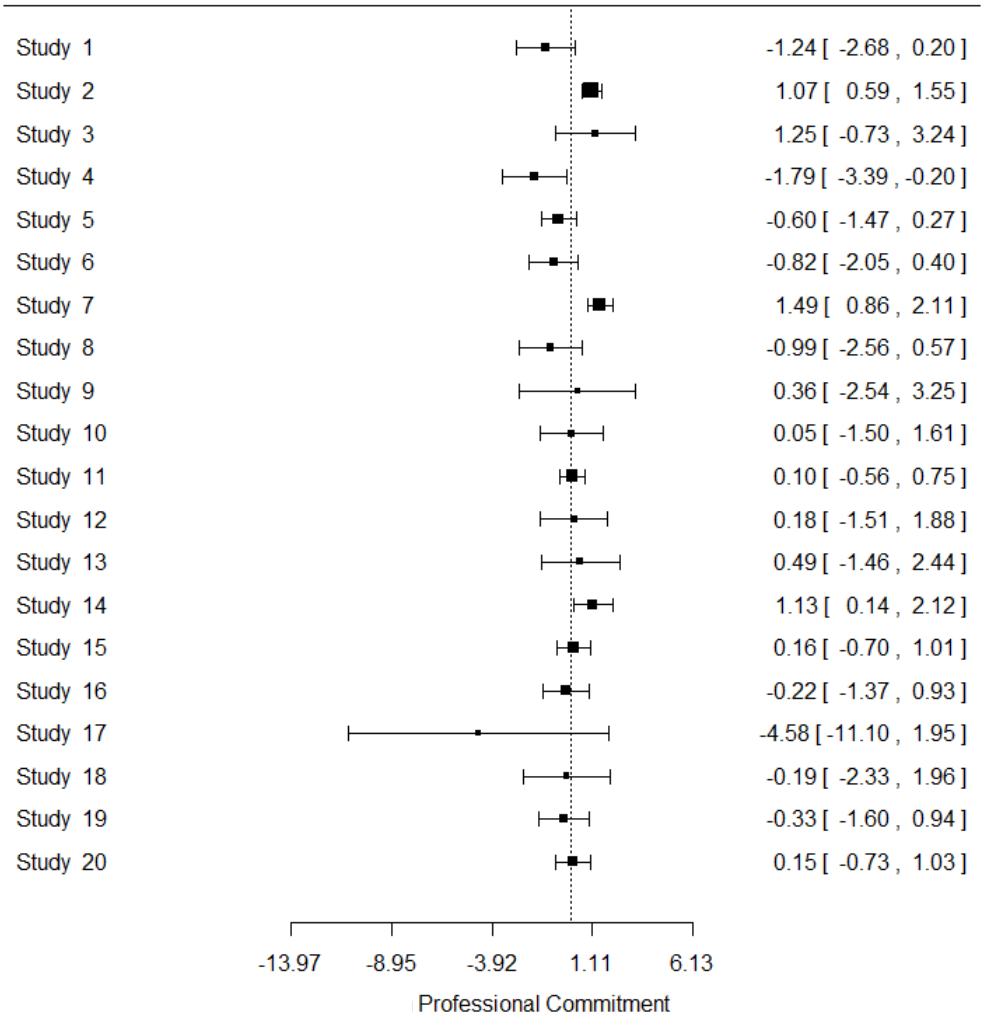


Figure 22: Forest Plot of Network Correlation β for Commitment to the Teaching Profession



6.2.2.2 Commitment - Organization

Based on the multilevel models, the main factors influencing a teacher's commitment to the profession of teaching were one's perception of instructional leadership (INST), reflective dialogue (REFD), collaboration concerning peer observation (COLB_OBS), in-degree centrality in the advice network (INDEG_AD), and out-degree centrality in the friendship network

(OUTDEG_F).[18] These five variables along with the two ρ parameters and the network correlation term were included in the model.

$$y_{Prof} = \rho_1 W_1 y_{Prof} + \rho_2 W_2 y_{Prof} + \beta_1 INST + \beta_2 REFD + \beta_3 COLB\_OBS + \beta_5 INDEG\_AD + \beta_6 OUTDEG\_F + \beta_7 NET\_COR + \epsilon$$

Table 20: Summary Results for Commitment to the Organization Autocorrelation Models

School	Advice ρ	Pr(>|z|)	Friend ρ	Pr(>|z|)	Network Correlation β	Pr(>|z|)
1	-0.3212	0.4095	-0.6587	0.0218	1.0878	0.0221
2	0.7342	0.0000	-1.4279	0.0000	3.1896	0.0000
3	1.5617	0.0328	-1.7716	0.0000	-2.1070	0.0002
4	0.2262	0.6946	-0.3286	0.5169	0.1503	0.7505
5	0.2676	0.5041	-0.2959	0.4478	-0.2512	0.6019
6	0.2296	0.6772	-0.0449	0.9409	-1.2806	0.1253
7	-0.6642	0.4066	0.3412	0.5654	2.9881	0.0109
8	-0.4703	0.1338	-0.0259	0.9280	0.6034	0.0972
9	-0.2058	0.5082	-0.4980	0.1828	-0.2460	0.6571
10	-0.4984	0.3871	-0.3800	0.2868	0.0889	0.7251
11	-0.3123	0.2811	0.2984	0.3929	0.3352	0.5116
12	0.6772	0.2041	-0.8013	0.0960	1.3344	0.0484
13	-0.2067	0.7346	0.4523	0.3122	0.6362	0.1679
14	0.8212	0.1296	-1.1629	0.0010	-0.4206	0.3496
15	-0.1907	0.8309	-1.1192	0.1132	1.1522	0.0245
16	0.1859	0.8101	-0.0651	0.9022	2.8391	0.0012
17	-1.3663	0.1311	1.0758	0.3107	-2.7219	0.0986
18	0.6602	0.1745	-0.4855	0.3271	-0.1797	0.8655
19	-0.8591	0.0595	0.7735	0.1978	0.0260	0.9622
20	0.5002	0.3957	-0.6968	0.3695	0.2519	0.7317

[18] There were several other variables that influenced commitment to the organization that were not included in the model due to the small number of teachers that exist in the elementary schools. Thus, only the most significant variables from the multi-level models were chosen as control variables in the commitment to the organization model.

Figure 23: Forest Plot of Advice ρ for Commitment to the Organization

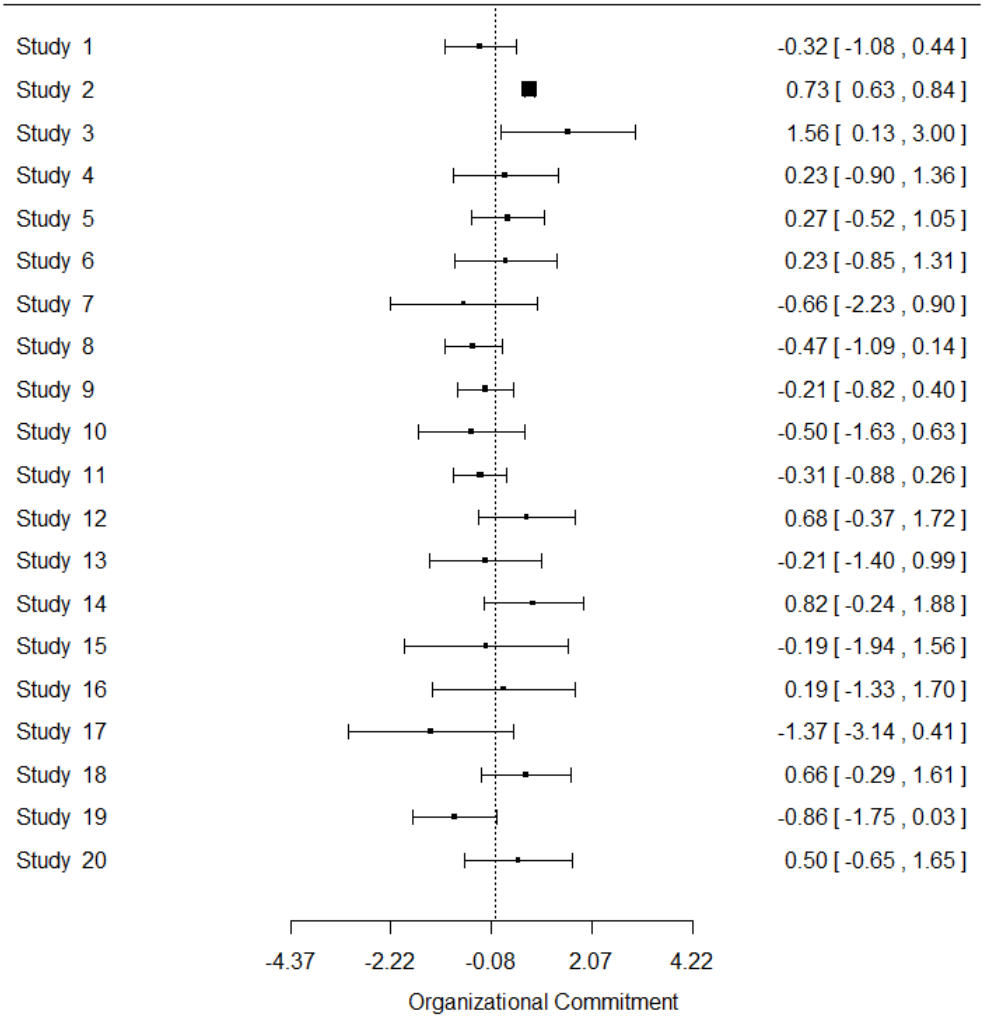


Figure 24: Forest Plot of Friendship ρ for Commitment to the Organization

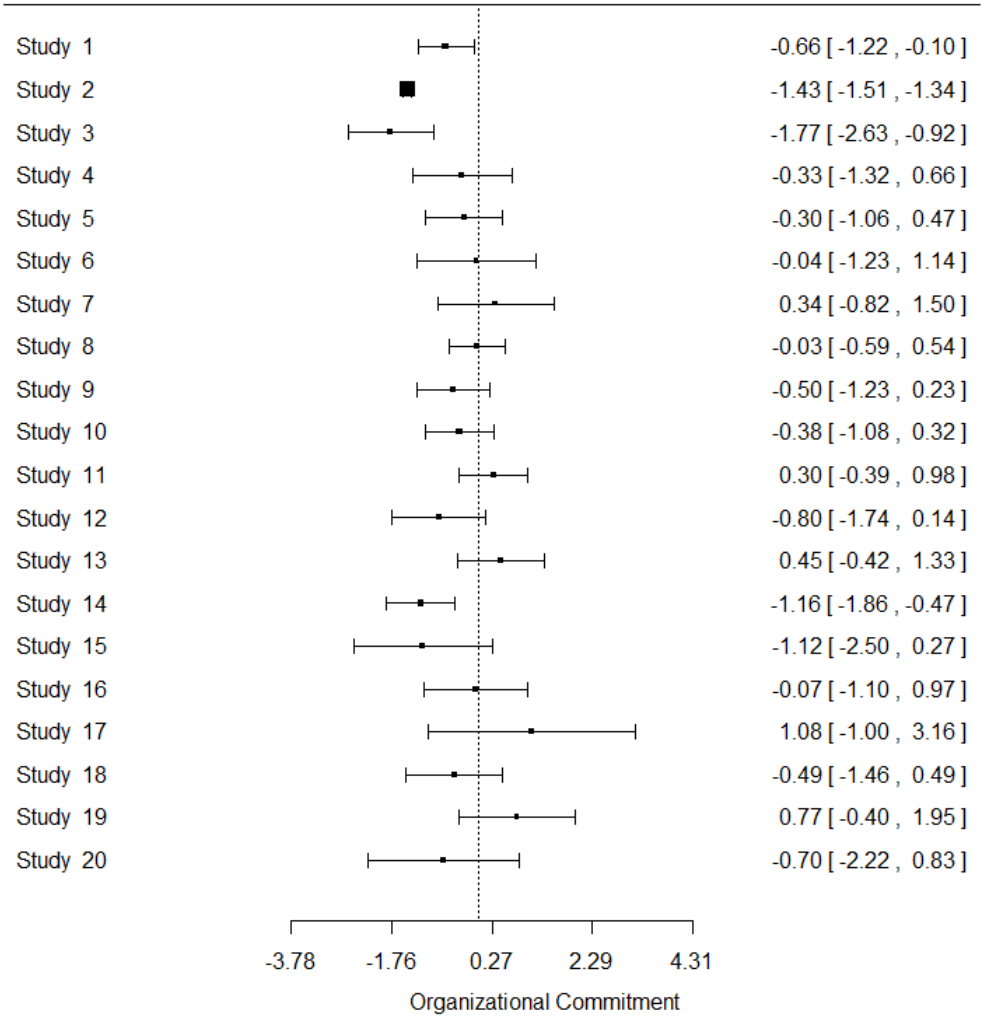
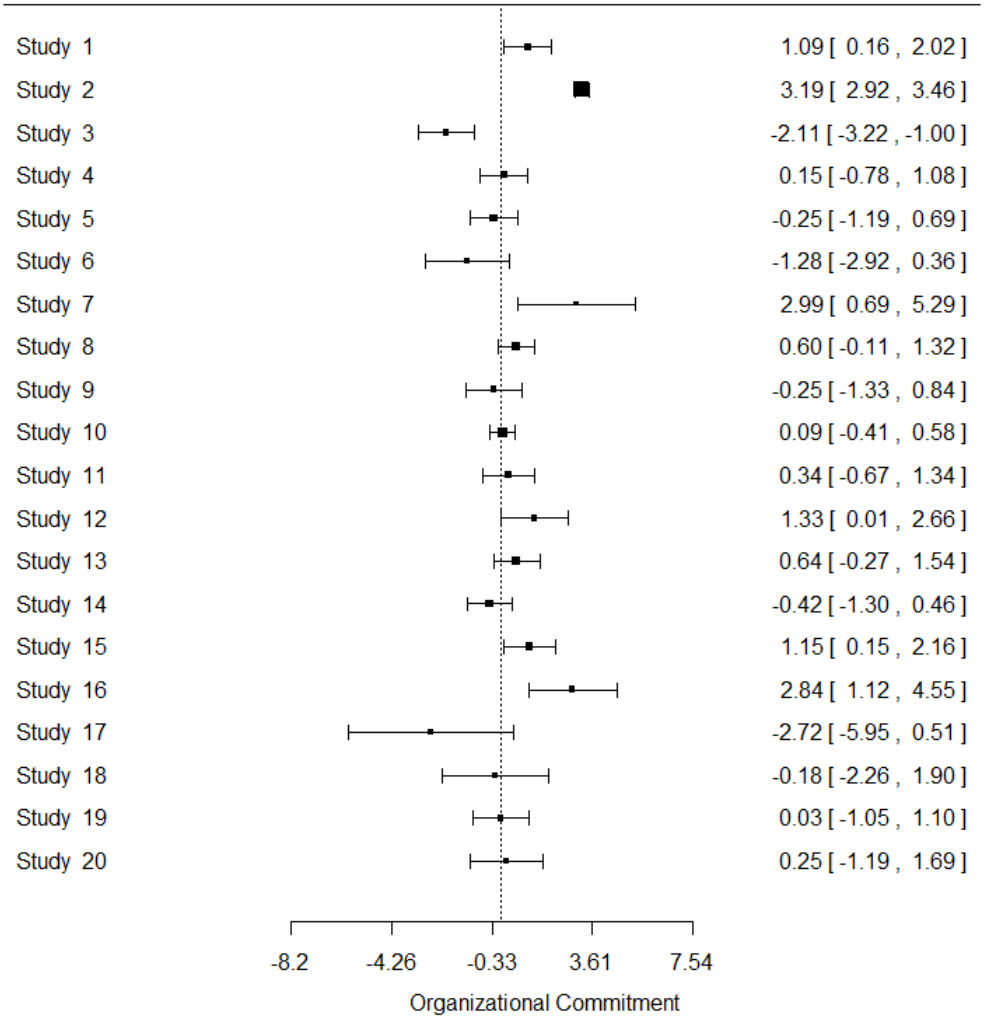


Figure 25: Forest Plot of Network Correlation β for Commitment to the Organization



6.2.3 Meta-Analysis of Network Autocorrelation Model Results

As easily evident from the output in the preceding section, the large number of models for each outcome variable make it difficult to discern any trend. While the forest plots offer a general impression of network influence, data synthesis is a necessary next step in understanding the role of social networks on efficacy and commitment. Thus, the ρ parameters and network correlation β for the 20 schools in the network autocorrelation models can be analyzed collectively through

meta-analysis to achieve an understanding of the population level effects on the five outcome variables. The procedures used to conduct the meta-analysis are identical to those used in section 5.2, except for the fact that the variation of the parameter estimates does not need to be calculated through simulation. Rather, the variance will be calculated directly from the standard error of the parameter estimate provided by the maximum likelihood estimation procedures used in the network autocorrelation models.

The first step in the meta-analysis process is to determine if the parameter estimates display sufficient homogeneity to assume they came from a single population. The Q statistic provides such a measure (please refer to section 5.2 for the computational details). If the resulting p-value of the Q statistic is not significant, then there is insufficient evidence to reject the null hypotheses that each of the parameter estimates came from a single population.

Table 21: Q Statistics for the Three Efficacy and Two Commitment Outcome Variables

	Advice Network		Friendship Network		Network Correlation	
	Q	*p*-value	Q	*p*-value	Q	*p*-value
Efficacy						
Student Engagement	3.4542	0.9999	2.1866	0.9999	1.8618	0.9999
Classroom Management	3.3594	0.9999	7.9308	0.9999	2.4253	0.9999
Instructional Strategies	3.1115	0.9999	4.7674	0.9996	2.6753	0.9999
Commitment						
Profession	7.7621	0.9889	3.2585	0.9999	3.3616	0.9999
Organization	4.0446	0.9999	7.2221	0.9929	22.8689	0.2432

Based on the results in Table 21, across each of the five outcome measures, the null hypothesis could not be rejected for the influence parameter in the advice and friendship networks, and thus the data was analyzed as coming from a single population. The null hypothesis could not be rejected for the network correlation effect either; and hence, this variable was also analyzed as coming from a single population. Based on this conclusion, meta-analysis

using Fisher's method to combine *p*-values was used to determine the significance of the pooled effects for each variable. Again, refer to section 5.2 for details.

Table 22: Meta-Analysis Results for the Three Efficacy and Two Commitment Outcome Variables

	Advice Network		Friendship Network		Network Correlation	
	ρ	*p*-value	ρ	*p*-value	β	*p*-value
Efficacy						
Student Engagement	0.3236	0.0000	-0.4608	0.0000	0.3520	0.0013
Classroom Management	0.1572	0.0043	-0.0906	0.0000	-0.0935	0.0124
Instructional Strategies	0.0209	0.0301	-0.2344	0.0000	0.8436	0.0000
Commitment						
Profession	-1.1152	0.0001	0.1872	0.0065	0.6118	0.0001
Organization	0.6437	0.0000	-1.3265	0.0000	1.9123	0.0000

Based on Table 22, advice relations exerted a significant social influence on the three efficacy beliefs. All of the population ρ parameters were significant at the .05 level. The structure of the advice network within a school, even after controlling for the variables found to significantly influence one's own efficacy, had a significant and positive influence on ego's beliefs. This is an important finding and shows how fundamental school outcomes are socially constructed.

For student engagement efficacy in the multilevel model, neither the advice in-degree nor out-degree was a significant predictor. The results of the autocorrelation model offer strong evidence that student engagement-efficacy is not simply a matter of seeking advice or being sought for advice from a large number of peers. Rather, it is the quality of the relationships (i.e. the attitudes of one's alters) that matter. In other words, the higher the student engagement efficacy of the peers ego seeks for advice, the higher ego's own efficacy. The population friendship ρ indicates an opposite effect - having ties to peers with high student engagement

efficacy tends to lower ego's own efficacy. This effect, which refutes hypothesis two, was found in the classroom management, instructional strategy, and organizational commitment model as well. The tendency for friends to negatively influence one's efficacy and commitment to the organization will be discussed separately and in more detail in section 6.2.4.

The population level effect of network correlation on student engagement efficacy was positive and significant. The meta-analysis indicates that teachers whose advice and friendship networks overlap, tend to have higher certainty about their ability to engage students.

Unlike student engagement efficacy, where no significant individual network effects were found in the multilevel models, the classroom management multilevel model indicated a positive and significant effect (p <.05) for in-degree centrality in the advice network. Thus, individuals who are more central in the advice-seeking network tended to have higher classroom management efficacy. The network autocorrelation models add an additional dynamic to this finding. First, the classroom management efficacy of ego's peers has a positive influence on ego's own efficacy. Second, when controlling for peer beliefs, the in-degree centrality in the advice network no longer has a positive effect. Across the 20 schools, the overall or population effect of in-degree centrality was -0.0136. An insignificant Q-statistic warranting meta-analysis revealed that the negative effect was significant at the .001 level. Therefore, controlling for the other factors, being highly central in the advice network has a small, negative consequence.

While quite small, this negative consequence of centrality has been found elsewhere in the literature given both the cognitive and time constraints placed on an individual occupying a central position. McFadyen and Cannella (2004) found a curvilinear relationship between the number of ties and new knowledge creation among a group of research scientists. At a certain level of interaction, the addition of new social connections has a negative impact. What is most

striking about the finding in the current context is that the dependent variable is personal perception of efficacy, and not a performance outcome. In the McFadyen and Cannella (2004) study, they argue that increasing connectivity beyond a certain level reduced outcomes due to the opportunity costs of maintaining the additional relationships. While there is clearly an opportunity cost for teachers providing advice to peers, it is surprising that this cost would detract from their own sense of efficacy.

Another unexpected finding was that of the five outcome variables, classroom management efficacy was the only one where network correlation had a negative effect. While relatively small, the effect of network correlation suggests that having separate friendship and advice ties can increase one's classroom management efficacy. As will be argued below in Section 6.2.4, discussions between friends can often turn to negative dialogue concerning problematic student behavior. Because of this, classroom management techniques could be a point of discussion in friend relations as well as in advice relations. Furthermore, affective ties in schools are not as detrimental to classroom management efficacy compared with the other outcome variables as seen by the small negative friendship effect. Hence, there appears to be some positive aspects of friendship ties in terms of teacher perception of classroom management efficacy.

Teacher instructional strategy efficacy was not significantly predicted by any of the individual network variables in the multilevel models. The meta-analysis of the network autocorrelation models revealed a small, but positive and significant effect of the instructional strategy efficacy of one's advice ties. As with the classroom management and student engagement, a negative influence was found for the friendship ties. The network correlation effect was positive and significant, and thus, for instructional strategy efficacy, teachers whose

advice and friendship networks were highly correlated tended to have higher levels of instructional strategy efficacy.

The meta-analysis results for commitment to the profession and commitment to the organization indicate different impacts of the advice and friendship networks. Teacher commitment to the profession was shown to be negatively influenced by advice ties but positively influenced by friendship ties. Therefore, the more a teacher's friends are committed to the profession, the more committed the teacher. Interestingly, the more committed a teacher's advice contacts, the less committed the teacher. The meta-analysis results for commitment to the organization showed the reverse effect. Organizational commitment was positively influenced by advice relations and negatively influenced by friendship relations. The direction of the findings for organizational commitment were aligned with the results of the three efficacy models. Thus, professional commitment had a different influence structure than all of the other outcome variables.

6.2.4 Addressing The Negative Friendship Influence

One of the more curious findings resulting from the network autocorrelation models was the negative effect of the friendship network on one's efficacy and organizational commitment. The findings from the network autocorrelation models revealed that in a majority of schools, having friendship ties with individuals with high values of efficacy or organizational commitment (but not professional commitment), resulted in lower efficacy or commitment for ego. Thus, influence spread along friendship ties in a potentially negative way. This finding was quite unexpected and deserving of additional investigation.

There are at least two processes that could lead to friendship ties imparting negative influence: (i) friendship ties that do not coexist with advice ties carry little teaching relevant knowledge, and (ii) friendship ties, unlike advice ties, support the flow of negative dialogue.

Theoretically, the negative influence of friendship ties could be due to the fact that teachers who associate with coworkers who maintain a high efficacy or commitment may begin to feel inadequate. This inadequacy may be most pronounced in social ties where friendship is present but advice providing is absent. In other words, a teacher in such a social relation would hear about all of the great things a friend does in the classroom or for the school, but does not receive the tacit knowledge or engage in the in-depth discussions needed to take on such behavior or strategies for himself or herself. This leaves the teacher feeling less certain about his or her own efficacy and commitment.

If a friendship tie does overlap with an advice tie, then a teacher not only acknowledges the high level of efficacy or commitment of a peer, but also takes part in an advice dialogue that imparts information and tools capable of improving that teacher's efficacy and commitment. In such multiplex relationships the negative influence of the friendship tie can be reduced.

Research evidence has shown that friendship ties in organizations are related to the spread of both positive and negative dialogue, while advice ties are related to the spread of positive dialogue (Grosser et al., 2010). Thus, friendship ties operate as the informal conduit in organizations through which negativity can be passed. In school settings, negative gossip and discussion often surround topics of poor student behavior, inability to engage students, and lack of student performance on exams (Rosenholtz, 1991). Teachers connected to highly efficacious teachers or highly committed teachers might be more influenced by such negative information. If a teacher hears "there is really nothing I can do to motivate a student" from a coworker with

high self-efficacy this may reduce that teachers own efficacy. But if the same dialogue was heard coming from a coworker with low self-efficacy, the teacher may be empowered to think "I could motivate that student if he was in my classroom." In these settings, a multiplex relation could limit the negative influence as well. The teachers could begin to discuss ways to motivate the student as well as tactics that have worked in the past for similar students. Thus, when negative dialogue occurs in multiplex ties, it may create an opportunity to engage in constructive information sharing that can limit the harmful effect.

To test these ideas, two new networks were constructed from the original advice and friendship networks. The first network contained ties between teachers that were formed solely based on friendship and therefore these ties capture a uniplex relation in the school. In other words, if a friendship tie also coexisted with an advice tie, that friendship tie was removed from the network. The second network consisted of friendship links between teachers who also shared an advice relation. Thus, the second network captures only multiplex ties. If the hypothesis that multiplexity diminishes the negative influence of friendship ties, then the ρ parameter for friendship only should be smaller (i.e. more negative) than the ρ parameter on the multiplex ties. The original models ran for each of the five outcomes were rerun, however, this time the friendship and advice networks were swapped out with the friendship only and the multiplex only networks.[19] Meta-analysis was once again used to pool the results across the 20 schools. The Q-statistics in Table 23 for each network in each of the five different models revealed that the parameter estimates from the 20 schools can be analyzed as coming from a single underlying population. Table 24 provides the results of the meta-analysis.

[19] Network correlation variable was dropped from the models because this variable is captured by the uniplex and multiplex networks.

Table 23: Q-Statistics for Uniplex and Multiplex Networks

	Uniplex Friendship		Multiplex Friendship	
	Q	*p*-value	Q	*p*-value
Efficacy				
Student Engagement	1.7930	0.9999	3.4121	0.9999
Classroom Management	3.2530	0.9999	4.7935	0.9996
Instructional Strategies	1.8967	0.9999	1.6617	0.9999
Commitment				
Profession	3.6010	0.9999	3.7234	0.9999
Organization	2.2775	0.9999	1.7560	0.9999

Table 24: Meta-Analysis Results for Uniplex and Multiplex Networks (considered jointly)

	Uniplex Friendship		Multiplex Friendship		
	ρ	*p*-value	ρ	*p*-value	***Change in ρ***
Efficacy					
Student Engagement	-0.2288	0.0004	-0.0815	0.0182	***0.1473***
Classroom Management	-0.1289	0.0139	0.0362	0.0528	***0.1652***
Instructional Strategies	-0.2240	0.0258	-0.0455	0.0599	***0.1785***
Commitment					
Profession	-0.4641	0.0000	-0.2224	0.0000	***0.2417***
Organization	-0.2684	0.0000	-0.1899	0.0126	***0.0785***

These results support the idea that uniplex friendship ties can lead to negative influence on efficacy and commitment outcomes, while multiplex ties diminish the potential negative influence. The findings suggest that the most likely mechanisms by which friendship ties exert negative influence is by creating a sense of inadequacy and by facilitating the spread of pessimistic sentiments about teaching or the school. Advice ties, which are not associated with negative dialogue, therefore tend to carry positive influence. More contextually grounded

qualitative network research investigating the content of information exchange between actors in friendship and advice networks would be an important next step.

6.2.5 Competition and Social Influence

The dominant policy theme of education reform today is competition. From the federal government's Race to the Top funds to the 2010 Obama Administration Teacher Incentive Funds that helped to spur districts use of pay for performance, teachers and school districts are being driven by competition. The pay for performance movement and the potential high stakes tied to value-added performance measures of teachers are creating environments where a teacher's salary and even job security are tied directly to how well he or she compares to his or her coworkers' performance. Competition, as the pursuit of individual goals where one's success means another's failure, may have unintended consequences in an organizational setting that is dependent on a technical culture and shared knowledge (Resnick, 1991; Spillane et al., 2001).

Competition, by definition, could potentially inhibit collaborative practices. This is a worrisome outcome of competition in schools that is not discussed or addressed by pay-for-performance advocates touting the benefits of competition. As discovered by Leana and Pil (2006), collaboration and social capital are critical components in schools because much of what teachers learn about being good teachers is socially derived (Bryk et al., 2010).

Furthermore, competition, by potentially breaking down the cohesiveness of a faculty, may also alter the type or form of information that is passed between interacting coworkers. In her work on the social organization of schools, Rosenholtz (1991) found that the type of collaboration in which teachers engage regarding the depth of advice and assistance varied significantly based on the cohesiveness of the faculty. In certain schools, teachers engaged in

"experience-swapping", primarily discussing negative interactions with students in their classroom. This mode of collaboration is designed to produce sympathy rather than support (Rosenholtz 1991). While teachers acknowledged that sympathy is often needed emotionally to deal with the stresses of teaching, "experience-swapping" does not impart technical or pedagogical skills needed to improve practice. A quote from one of Rosenholtz (1991) interviews provides a telling example:

> "We share things about our classes. My class this particular year has been particularly rough. There's been a lot of sympathy from other teachers. They agree that it's an unusual group of kids. I'm not saying that it's any one person's fault, but there's not a feeling of teamwork in the school. They teachers don't really give me any input as to how to handle this problem (p. 53)."

One of the conclusions reached by Rosenholtz (1991) is that collaboration in certain school settings can reinforce negative beliefs and uncertainty about teaching, while in other settings, collaboration can develop a sustained technical culture where teachers continually request and offer advice about instructional issues. Thus, there appear to be at least two potential negative effects of competition: it may reduce collaboration/cohesiveness and it may alter the effect of social connections in schools by modifying the content that passes through a social tie.

A measure of competition in the Finley School District can be derived from a subset of the survey items that were used to measure trust. Two questions in particular are directly applicable to assess a teacher's perception of the competition felt among his or her peers. Teachers were asked to rate their level of agreement with the following two statements: (i)"Teachers in this school feel as though they are in competition with fellow teachers", and (ii) "Teachers in this school typically look out for each other." The first item, given its negative wording, was rescaled so that larger values indicated a positive response. A combined average

of the two items across all teachers within a school is used as a measure of competition. The higher the value of the measure in the school, the less competition perceived by teachers.

The effect of competition on collaboration can be tested by looking at the association between competition and density in the teacher networks. The results of the correlation tests across the 21 schools are shown in Table 25.

Table 25: Correlation Between Competition and Density in Advice and Friendship Networks

	Correlation	p-value
Advice Network	0.2780	0.2224
Friendship Network	-0.0014	0.9952

While reduced competition is positively associated with advice network density, the effect was not significant, though this may be a result of the limited sample size. There was no effect of competition on friendship. The results suggest that increased competition does not limit collaboration within the school. Competition and collaboration need not be mutually exclusive. Although with additional data, a significant effect between increased competition and reduced density in the advice network could be found.

The second impact of competition (that it may serve to alter the value of what is spread through social networks) can also be tested. The Q-statistic in the original models (Section 6.2.3) indicated that the results across the schools can be assumed to come from a common population. However, within the forest plots for both advice and friendship networks there are a few schools with significant negative effects, a few with significant positive effects, and many schools with confidence intervals that include zero. Within this distribution of network effects, the ones in the left tail where social networks have a significant negative effect provide an interesting opportunity to investigate how competition might alter the influence of social connections in those environments.

A simple t-test was used to assess how schools with significantly negative network effects have different average teacher perceptions of competition than schools without significant negative effects. Schools were initially separated into two categories - those schools with one or more significant negative network effects across the five dependent variables and those schools without any significant negative network effects. In addition, schools were separated into two other similar groupings. One grouping that consisted of schools that had two or more instances of negative network effects compared with all other schools and another grouping that contained schools with three or more instances of negative network effects compared with all other schools. As seen in Table 26 below, all three groupings indicate that competition was higher in schools that had significant negative network effects (recall the higher the mean score the lower the perceived competition). As the groups became more restricted based on a larger number of negative effects, the differences in means became larger and the significance in the differences increased as well.

Table 26: Comparing Average Competition Between Schools

	Group 1: Schools with Negative Slopes	Group 2: All other schools	Difference	*p*-value
One or More Negative Slopes	7.4400	8.1230	-0.6830	0.0370
Two or More Negative Slopes	7.1390	7.9270	-0.7880	0.0316
Three or More Negative Slopes	6.9130	7.7870	-0.8740	0.0046

The evidence implies that competition may alter the function and the value of collaboration. Teachers' impression of competition with their peers in a school appears to be a

significant driver of the type of collaborative environment that develops. The negative influence of social connections in schools with greater perceived competition may be due to a reduction in the range and depth of dialogue that occurs. Teachers in these schools may find themselves engaged in more "experience-swapping" than deep pedagogical discussions that disseminate tacit knowledge. Because information offered when teachers engage in experience-swapping tends to be negative, these relationships can be counterproductive; especially when a person with lower efficacy hears a highly efficacious person stating how much trouble they are having with a particular student or classroom. The less certain teacher may begin to think, "If she is unable to reach these students, how am I ever going to?" As a result, when faculty dialogue consistently entails complaints suggesting that no teacher can succeed, teachers will become less sure of their own capacity to perform in the classroom (Rosenholtz 1991). Thus, the unexpected negative influence of social networks in certain schools can be a direct result of competition influencing the depth and nature of teacher interaction. A follow-up study into this dynamic would ideally engage in qualitative and ethnographic research of schools and teachers in high competition settings versus low competition settings to understand how the function of the networks and content passed through them differ.

6.2.6 Threats to Validity

One of the major threats to validity regarding social network models is selection. One may observe individuals with similar values on a response variable not due to processes of influence or contagion but rather processes of selection. Relationships may form solely based on the similarity of the response variable between two actors rather than their response variables becoming more similar due to social closeness. For example, teachers who are very committed

to the school may tend to become friends with one another or seek each other out for advice. If this type of selection process is at work in schools then the preceding results could be an artifact of selection and not influence. Influence occurs when a teacher has an advice or friendship relationship with a coworker and through that interaction their beliefs and attitudes become more similar.

Based on the results in Chapter 5 concerning the antecedents of network formation, advice ties predominately form because teachers teach a similar grade and because the coworker perceives another as being trustworthy. To a lesser extent tie selection was influenced by perceptions of being a hard worker, competent, and amicable. The perception data can be used to assess the threat of selection on the network autocorrelation findings. Selection effects occur because individuals are inclined to form social ties with others who hold similar attributes or beliefs. Therefore, in order for selection effects to transpire, an individual must acknowledge the trait or belief in a coworker that is the basis for selection. If actors in a network are unable to evaluate in some capacity, whether by proxy or directly, the variable upon which selection effects are posited, then it is highly unlikely that selection is the causal factor driving similar outcomes.

In the qualitative interviews the concept of self-efficacy was never mentioned during the implementation of the role repertory grid methodology. Self-efficacy was not a trait that teachers saw as being an important factor in how they cognitively view and understand the individuals that comprise their work environment. Because self-efficacy is a personal belief about one's own ability, it is a difficult concept for others to assess, and this may be a reason why it was not explicitly mentioned. However, this does not preclude efficacy from being a basis of tie selection. Individuals may form ties with others based on their perception of other traits that

are correlated with self-efficacy, and thus through this proxy assessment, ties are formed based on similar levels of efficacy.

One way to assess the threat of selection on efficacy is to determine how well interpersonal perceptions on the measured traits can predict self efficacy. For instance, from the perspective of a coworker, the trait most logically linked to one's self perception of efficacy is competency. Thus, a teacher's average measure of competency as rated by their coworkers may potentially be highly correlated with that person's sense of self-efficacy. If peer assessment of a teacher's competency is correlated with that teachers sense of self-efficacy, then the threat of tie selection based on the response variable is an actual threat. The other traits can be tested in the same manner by running a simple linear model and assessing how well coworker perception on all 11 traits predicts the three efficacy measures. If coworker perception on the traits does a poor job of identifying someone who has high efficacy, then it is less likely individuals are selecting peers to go to for advice or friendship because they have high efficacy. Table 27 below displays the results of a simple OLS regression on the three self-efficacy variables.

Table 27: OLS Results, Predicting Self-Efficacy Based on Peer Trait Ratings

	Student Engagement		Classroom Management		Instructional Strategies	
(Intercept)	-1.1453		-0.6521		0.1050	
Approachable	0.5554		0.0772		-0.1990	
Caring	0.4153		-0.3589		0.2387	
Collaborative	-0.4275		0.1350		0.7682	*
Competent	-0.5324		-0.5253		0.2486	
Flexible	0.3400		-0.0677		-0.1014	
GoodListener	-0.5071		0.3107		-0.1269	
Hardworking	0.9209	**	0.6973	*	-0.2031	
Modest	-0.5946		0.2114		0.1262	
OpenMinded	0.1556		0.1053		-0.6871	
Positive	-0.1002		0.5700		0.1097	
Trustworthy	0.109		-0.9688	**	-0.1792	
R-squared	0.1064		0.1201		0.0664	
N	111		111		111	

*** - significant at .001 level; **-significant at .01 level; *significant at .05 level

The results imply that teachers average perception of a coworker along all 11 traits was not highly correlated with that coworker's sense of self-efficacy. If perception on these traits are indeed the primary cognitive drivers of social behavior, then the threat of selection being the causal mechanism, rather than influence, in the network autocorrelation models is greatly reduced as teacher perceptions are not predictors of another teacher's self-efficacy.

Unlike efficacy, commitment to the profession or organization, may be more easily perceived by coworkers. Individuals can stay late, take on leadership positions, or champion a reform movement. These tangible aspects of commitment offer coworkers a capacity to recognize another's commitment to the organization and to the profession. On the surface then, the threat of selection based on commitment appears more plausible. As with efficacy, the traits can be used to assess how well they predict one's commitment. If the average peer rating on the traits are highly predictive of commitment, then is plausible that teachers select other teachers

based on commitment because they are able to distinguish people with high commitment from those with low commitment. Figure 28 below provides the results of the OLS models attempting to predict commitment to the organization and commitment to the profession.

Table 28: OLS Results, Predicting Commitment Based on Peer Ratings

	Profession		Organization	
(Intercept)	-1.6719	*	-4.0399	***
Approachable	-0.4811		-0.8468	*
Caring	0.5656		-0.1038	
Collaborative	1.0893	**	0.2947	
Competent	0.1551		-0.9446	***
Flexible	-0.1351		0.1139	
GoodListener	-1.1997	*	-0.6392	
Hardworking	0.1137		1.4447	***
Modest	-0.0800		0.1524	
OpenMinded	0.1259		0.5711	
Positive	0.6579		0.5820	*
Trustworthy	-0.4408		0.3959	
R-squared	0.2369		0.3708	
N	111		111	

*** - significant at .001 level; **-significant at .01 level; *significant at .05 level

The results above indicated that commitment to the profession and commitment to the organization could be moderately predicted by peer ratings on the ten key traits. Thus, it is possible that selection occurred among teachers in a school based on commitment. However, the particular traits that have significant effects varied for commitment to the organization and commitment to the profession. Thus, it would be difficult to think of a situation in which selection occurs on both professional and organizational commitment.

An additional reason to discount the impact of selection is due to the fact that there are five dependent variables for which selection needs to occur on. Because the same advice ties

and friendship ties are used in predicting these outcomes, if a teacher selects a coworker to form an advice tie based on commitment to the profession, that teacher cannot also choose that person because of their classroom management-efficacy as these variables are not highly correlated.

6.2.7 Summary of Network Autocorrelation Models

Given the data, there is no way to statistically separate influence from selection. Overall though, the network autocorrelation models strongly suggest that teachers are influenced by their peers' perception of self-efficacy and commitment. While quantity of network activity was shown to have little effect on most outcome variables in the multilevel models, quality of social connections was strongly predictive in the network autocorrelation models. Thus, simply being active in a network does not bring benefits of increased efficacy or commitment. Rather, the social aspects of these outcomes are driven by the attributes of one's connections in the network, not the amount of connections. The results push back against an overly structuralist perspective, and call for more attention to be paid to the individual characteristics of actors in the network. Both position and the attributes of one's connections must be considered jointly. This is a critical finding for schools looking to increase the level of collaboration in schools. Collaboration for collaboration sake may not lead to any improvement. Individuals must seek out and maintain ties to individuals who can provide positive influence.

Data analysis results in this section revealed that uniplex friendship ties in schools can be potentially harmful. Friendships that form between teachers who do not also share advice or engage in meaningful dialogue about teaching can result in unintended consequences. Designing opportunities for teachers to work with friends on school related activities may help form the

multiplex ties that can potentially eliminate the negative effect of non-advice providing friendships.

Lastly, a teacher's sense of competition among teachers has the potential to alter collaborative benefits. While competition did not significantly reduce the amount of collaboration in schools, it appeared to modify the types of information that networks disseminate. In high competition schools, social networks, both advice and friendship, can have negative and harmful effects on teacher efficacy and commitment. This finding runs counter to the current education reform policy that consistently promotes the value and need for greater competition.

7.0 CONSEQUENCES OF NETWORK STRUCTURE - PERFORMANCE

Networks play an important role regarding individual self-efficacy and commitment. The network autocorrelation models revealed that beliefs and attitudes are influenced in both positive and negative ways by the peers one associates with. While efficacy and commitment are two important variables that have implication for teacher and school success, neither directly measures performance. The goal of this section is to assess how networks shape the performance of individual teachers.

Unlike most other organizational contexts, schools provide a great opportunity to objectively measure individual performance. Teachers are primarily charged with the task of student learning and the primary measure of student learning is performance on standardized exams. Using longitudinal district data that links students to teachers, a value-added measure of teacher performance is calculated. This section attempts to model variation in the value-added scores of reading and math teachers.

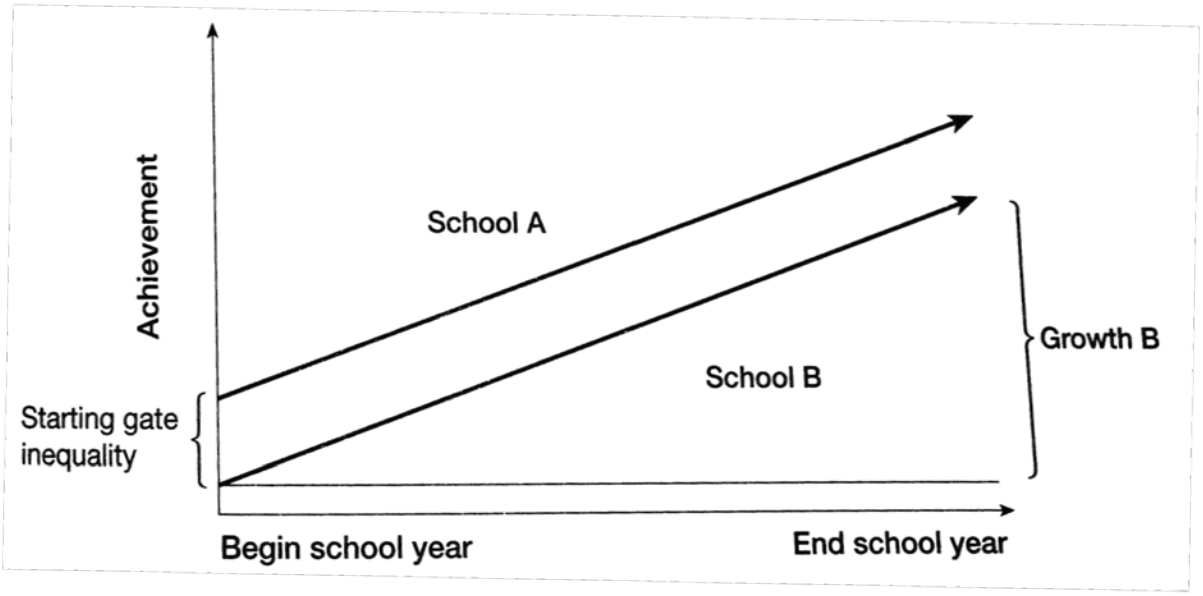
7.1.1 Calculating Value-Added Measures of Teacher Effectiveness

There are several ways teacher performance can be measured in a school. In many districts, teachers are provided with an annual or bi-annual assessment of their performance. These

assessments are primarily conducted by the principal and teachers are placed into a satisfactory or unsatisfactory category. The problem with such measures is not only their subjectivity, but the fact that when schools utilize these rating systems 99% of all teachers are placed into the satisfactory category (Harris, 2011). Thus, providing no variation from which to judge teacher performance.

Another potential way to measure teacher performance is to use the average test score of the students in a teacher's classroom. This measure is flawed for several reasons. One, it fails to take into account the fact that large differences in student performance are found between high and low income students and high and low income schools. Students enter a classroom with different levels of academic skill, something referred to as starting-gate inequality. Thus, teachers who happen to teach in upper-class districts will almost always enjoy students with higher test scores than their peers teaching in lower-class districts. Furthermore, the average student performance measure is flawed because it does not assess the portion of the student test score that can be attributed to the teacher as average scores do not account for gains. Figure 26 provides a visual example.

Figure 26: Average Score versus Growth (image from Harris 2011)



School A and School B are both improving student scores at the same rate. However, because School A enjoys a higher starting-gate value, it consistently appears to outperform School B. Looking at the diagram though, it is difficult to say that School A's teachers are doing a better job at improving their students' test scores than the teachers in School B. This is why average test scores can be misleading. They mask the actual impact of a teacher or school.

Value-added measures overcome the flaws in these other measurement systems by using statistical tools to isolate the component of student learning that can be attributed to teachers, while controlling for other factors such as a student's prior achievement, race, gender, socio-economic status, and English second language (ESL) status. Conditioning on a student's past achievement on a standardized exam controls for unmeasured student factors that persists from year to year such as parental support, intelligence, ability, and effort. Because these latent factors are controlled for, the statistical model is capable of yielding estimates of the contribution

of the student's current teacher to the student's current performance. For an in-depth discussion of value-added models in education see Harris (2011).

The data provided by the Finley School District contained student test score data for the school years of 2007-2008, 2008-2009, 2009-2010, and 2011-2012. The data contained each students' score on the reading and math, the student's reading and math teacher, and the students' race, gender, ESL status, individual education plan (IEP) status, and free or reduced lunch status.[20]

Based on this data, the statistical model used to calculate value-added scores contained all of the student demographic variables, a teacher indicator, and previous test performance. While the district data contained a link between student and teacher, it did not identify the particular classroom in which a student was enrolled. Because of this, the statistical model was unable to control for aggregate level classroom variables. However, based on the findings of Buddin (2011) in his work with Los Angeles Unified School District (LAUSD), teacher effects were relatively stable regardless of whether classroom effects were controlled for or not. Additionally, Gordon, Kane, and Staiger (2006) choose not to control for mean characteristics in the classroom as such measures can give too much credit to teachers assigned to classes with more disadvantaged students.

The standardized tests taken by students in Finley are vertically scaled tests. Vertically scaled tests are designed such that performance in each grade is on the same scale. The scores are directly comparable overtime and the change in a student's score from one year to the next represents an increase in subject knowledge. Thus, student scores in higher grades are, on average, greater than the scores of students in lower grades. The vertical scaling of the

[20] Free or reduced lunch status is a commonly used proxy for a student's socio-economic status.

standardized test provides an efficient way to track student progress year by year. The vertically scaled state standardized tests are taken by all students in the district in grades 3,4,5,6,7,8, and 11 in both reading and math. In order to assess the student gain attributable to the current teacher, value-added models require a pre-test score, and consequently only teachers in grades 4 through 8 were eligible to have a value-added score. A separate model was run for each grade and each subject for the 2009/2010 school year (referred to as 2010) and the 2010/2011 school year (referred to as 2011). Based on the work of Gordon, Kane, and Staiger (2006) the statistical model used to calculate teacher value-added in math is defined as:

$$Math\_Score_{it} = \beta_{1gr,yr} Math_{it-1} + \beta_{2gr,yr} Math_{it-2} + \beta_{3gr,yr} Read_{it-1} + \beta_{4gr,yr} Read_{it-2} + \lambda_{1gr,yr} IEP_{it} + \lambda_{2gr,yr} FRL_{it} + \lambda_3 Race_{it} + \lambda_4 Gender_{it} + \Upsilon_{1gr,yr} Math\_Teacher_{it} + \varepsilon_{it}.$$

The dependent variable is the math score for student *i* in year *t*. A students prior performance in years *t*-1 and *t*-2 were controlled for in both reading and math. IEP is a variable indicating whether the student has an individualized education plan, and FRL is a variable indicating if the student's household income is low enough to qualify for free or reduced lunch. The primary variable of interest is the coefficient value for Math_Teacher, which provides an estimate of the student's test score gain that can be attributed to his or her math teacher in year *t*. The value added model for reading was the same as the one displayed above for math except the dependent variable is now the student's test score on the reading standardized exam, and the teacher variable of interest indicates the reading teacher for the student in year *t*.

The models across each grade were also identical, except for the fact that in grade 4 only one previous exam could be used (as only one is available), but in grades 5-8, two previous exams were used as control variables to help improve the accuracy of the teacher effect

estimates. The coefficient score for each teacher is the value-added estimate for a particular grade-subject combination in year *t*. The models detailed above were run to predict a teacher's value-added in both the 2011 and 2010 school year.

Because there is year to year variability in the test and potential systematic variability in the average student test score gain in a given year, a teacher's value added scores were grand mean centered for each grade-year-subject combination. These grand mean centered value added scores were then combined across grades for both math and reading to produce a list of teacher scores in 2010 and a list of teacher scores in 2011. Because some teachers, especially those in middles schools, teach multiple grades in any given year, several teachers had a value added score for two different grade levels. For teachers that taught in more than one grade, a precision weighted average of their value-added scores was calculated. The weighted mean was calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n}(x_i/\sigma_i^2)}{\sum_{i=1}^{n}(1/\sigma_i^2)},$$

where x_i, is the value-added measure for the i^{th} occurrence of the teacher and σ_i^2, is the variance associated with the measure. The variance of the weighted mean is calculated as:

$$\sigma_{\bar{x}}^2 = \frac{1}{\sum_{i=1}^{n}(1/\sigma_i^2)}.$$

The results for the year 2011 became the primary performance variable as this is the school year in which the survey and network data were collected. Missing value-added scores for teachers in 2011 were replaced with the value-added scores calculated for 2010. Missing values could arise for several reasons -- the teacher may have taught a grade in 2011 that wasn't suitable for value-added estimates or the teacher had not taught enough students to allow for the calculation of a value-added score. The resulting 2011 dataset produced math value-added

measures for 119 teachers and reading value-added measures for 121 teachers. Figures 27 and 28 display a histogram of the value-added scores in math and reading.

Figure 27: Histogram of Teacher Value-Added Scores in Math for the 2011 School Year

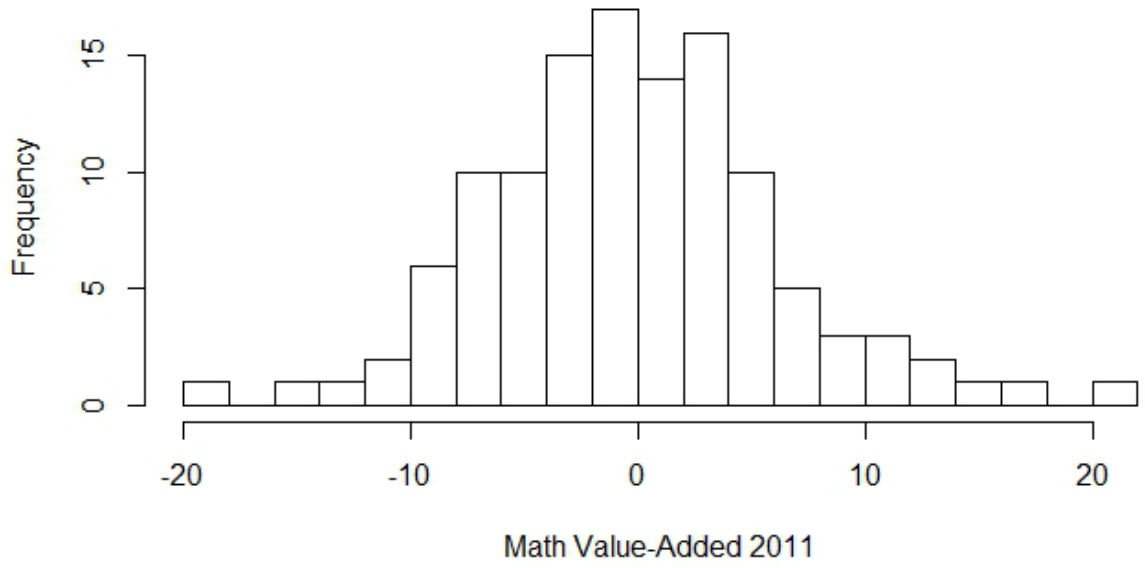
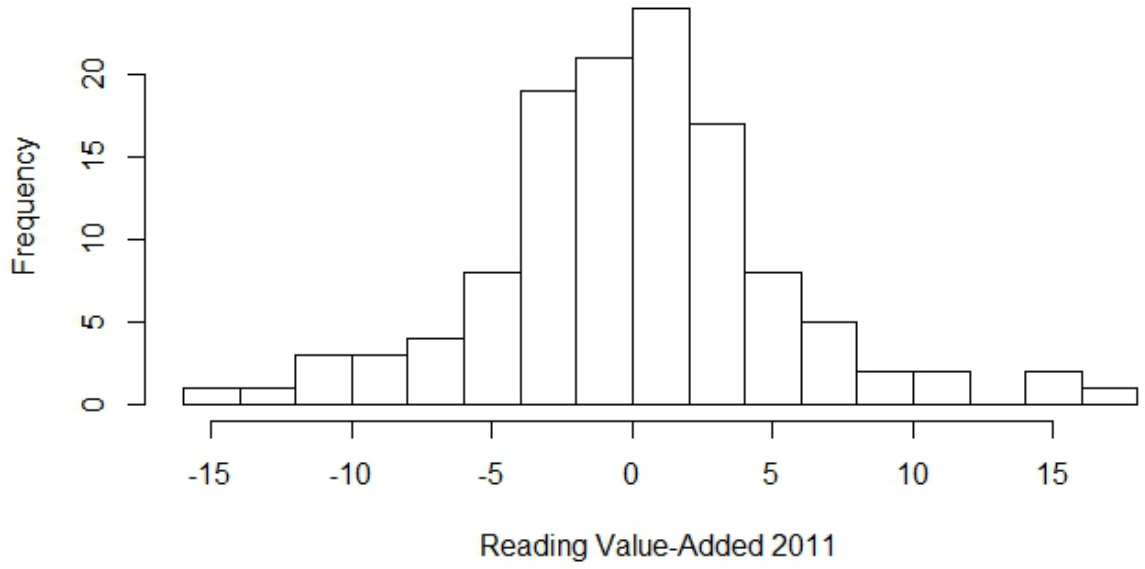


Figure 28: Histogram of Teacher Value-Added Scores in Reading for the 2011 School Year



As evident in the histograms, there is fairly wide variation in both reading and math value-added across teachers. It is precisely this variation that the following models try to predict. The next section discusses the development of the primary predictor variable, teacher social capital.

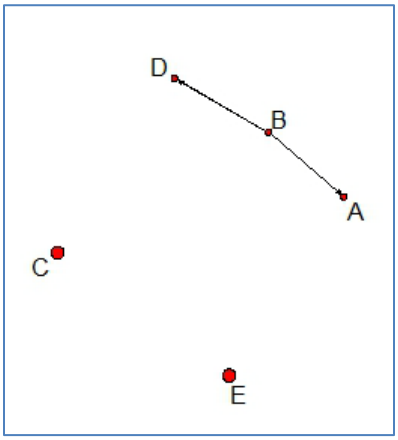
7.1.2 Measuring Social Capital in Schools

Social capital has been viewed as both a resource that accrues to individuals based on their social connections and a resource that supports a collective of individuals based on the cohesiveness of the group. This section will look to develop a straightforward though sophisticated measure of social capital, one that will be used as a predictor of a teacher's value added score.

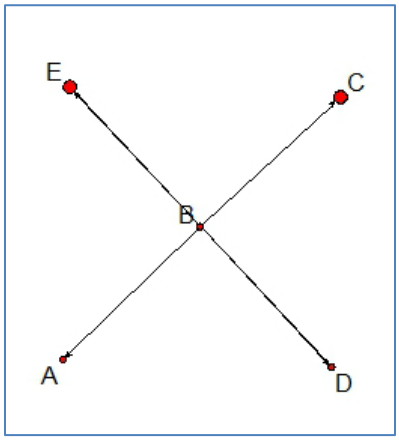
Given that social capital arises through connections to others, a simple social capital measure could sum the number of connections held by each actor. However, this approach ignores the quality of the connections with regard to the resources owned by the alters. Furthermore, a simple centrality measure assumes that having many weak ties in an organization is better than having a few strong ties. Previous research has argued that for tacit knowledge and beliefs to spread within a group, strong ties are necessary (Hansen, 1999), while information and job opportunities spread easily along weak ties (Granovetter, 1973). Thus, one needs to understand the organizational context, the type of information that needs to be spread, and the processes by which contagion or influence occur.

Figure 29 below, depicts 8 archetypal networks in which one could be embedded. In these images, actor B is the focal actor and the ties among alters are ignored. The networks vary (i) in the number of ties held by actor B, (ii) the strength of the tie between actor B and his or her alters (indicated by line thickness), and (iii) the resources held by actor B's alters (indicated by node size).

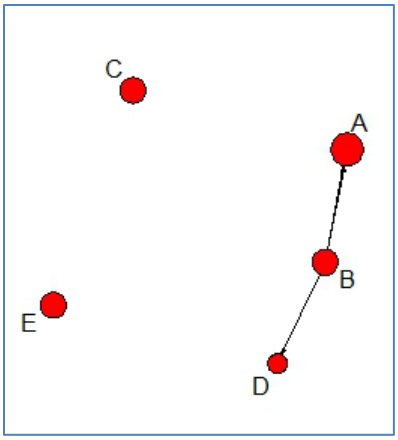
Figure 29: Eight Archetypal Networks that Vary in Tie Quantity, Strength, and Alter Resources



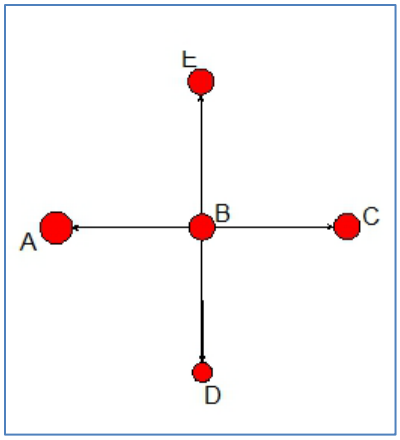
a. Few weak ties, weak resources



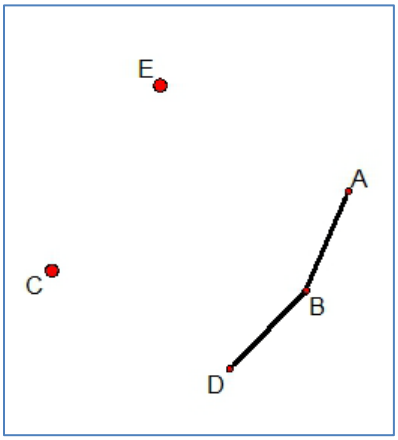
b. Many weak ties, weak resources



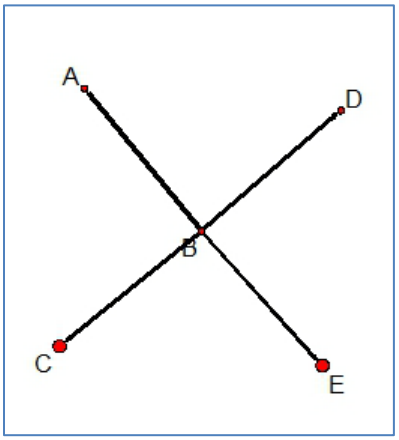
c. Few weak ties, strong resources



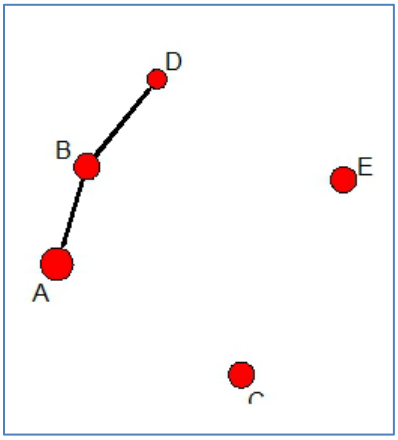
d. Many weak ties, strong resources



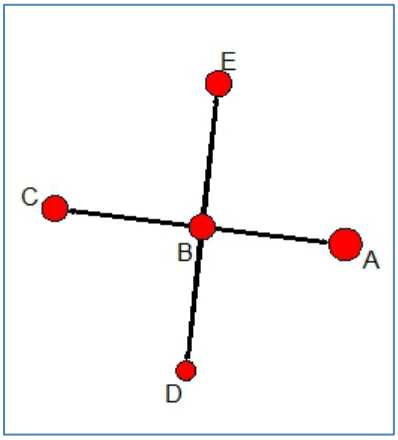
e. Few strong ties, weak resources



f. Many strong ties, weak resources



g. Few strong ties, strong resources



h. Many strong ties, strong resources

The diagrams clarify why an approach to social capital using common measures of network activity and centrality would face similar criticisms to those raised by Opsahl et al. (2010). When using a simple degree calculation, the strength of ties are ignored. When using a sum of the tie weights, the number of connections is ignored. In both instances, the resources available from one's alters are ignored. While Opsahl et al. (2010) offer a more refined and theoretically driven way to calculate centrality in weighted networks through the use of a tuning parameter, the measure only provides an estimate of one's connectedness, and cannot be used to assess resource availability based on that connectedness.

One potential solution would be to multiply an actor's centrality score by the average resources available from the actor's alters. So for instance, actor A may have a centrality score of 8.0 and the alters he or she is connected to may have average resources of 2. Thus, actor A's social capital would be 16. However, this approach to social capital ignores a critical issue shown in the diagrams above - one can have varying tie strengths to varying resources. The following table provides an example.

Table 29: Why Egos' Social Capital Measure Should Vary Even Though Centrality Score and Average Resource Access are Identical

Scenario 1

Ego	Alter	Tie Strength	Alter's Resources
A	B	4	1
A	C	2	1
A	D	1	3
A	E	1	3

Scenario 2

Ego	Alter	Tie Strength	Alter's Resources
A	B	1	1
A	C	1	1
A	D	2	3
A	E	4	3

In both Scenario 1 and 2, actor A has a weighted centrality score of 8 and an average resource access of 2. However, in the first scenario the actor has strong ties to weak resources, where in the second scenario, the actor has strong ties to strong resources. Simply multiplying a centrality score by average resource access does not capture these differences. A more complete measure of social capital would take into account three things: the number of connections, the strength of connections, and the resources available through those connections (Penuel et al., 2010). A better way to assess social capital, especially in organizations where strong ties are important facilitators of knowledge and information transfer would be through matrix multiplication. This would give the actor in the first scenario a social capital score of 12, and the actor in the second scenario a score of 20.

Multiplying the network ties by the vector of resources does not solve all of the issues. The approach produces larger estimates for individuals with more numerous ties because each tie offers at least some resources (if resources are scaled between 1 and some positive number). However, as found in the network autocorrelation models, individuals who seek advice from others with low efficacy, will tend to have a reduced efficacy themselves. Thus, even though each teacher has some amount of self-efficacy, if an alter's efficacy is low relative to the rest of the network, the result of that tie can actually be negative. Therefore, the resources held by each actor in the network should be scaled to capture this effect. Ties to an individual with low resources may produce negative results, either because the individuals commitment is low and through social connection ego's commitment drops as well, or because the expense of maintaining a tie outweighs any benefit that can be gained from the poor resources available through that link.

Therefore, social capital measures need to scale the resources available in the network to more accurately reflect the processes uncovered in schools. Concerning the most appropriate resources to consider in the social capital calculation, the literature indicates that teacher performance should be positively affected by efficacy (Tschannen-Moran and Hoy, 2001; Tschannen-Moran et al., 1998) and commitment (Rosenholtz, 1991). As the network effects models demonstrated, efficacy and commitment are socially influenced. Two questions concerning performance follow this finding. One, does a teacher's performance, as measured by value-added models, depend on his or her sense of efficacy and commitment. Two, does a teacher's performance depend on the efficacy and commitment of the peers he or she goes to for advice. It is possible that advice ties with highly efficacious peers or highly committed peers may provide greater performance benefits than ties to less efficacious or less committed peers. Therefore, the efficacy and commitment of teachers can be seen as a form of social capital that can be accessed via social connections. Following the logic outlined above, social capital can be measured by multiplying a teacher's social connection to each alter by the efficacy and commitment of that alter.

7.1.3 Predicting Teacher Value-Added Scores

As discussed above, the 2011 value-added dataset produced reading value-added measures for 121 teachers and math value-added measures for 119 teachers. When combined with the survey data, complete observations were available for only 90 teachers in reading and 82 teachers in math. The small number of complete observations limits the extent of the model. Multilevel modeling could once again be used given the inherent nesting. However, the low number of observations per school (approximately four) impacts the power of the multilevel model. In

addition, the ICC was calculated for math and reading as the dependent variable, and revealed practically zero variance at the school level (Math ICC = 1.643e-09, Reading ICC = 3.117e-10). Thus, there is no evidence to support the need for multilevel modeling and consequently teacher performance measures are assumed to be independent of one another.

Given the limitations of the datasets containing value-added measures, a modest attempt at understanding the role of social connections on performance is conducted. For both the reading value-added and the math value-added scores four models were compared. The first model consisted of demographic attributes only. The second model consisted of the demographic attributes along with several survey items. The survey items included were a teacher's classroom management efficacy, student engagement efficacy, instructional strategy efficacy, commitment to the profession, and commitment to the school along with the teacher's perception of competition in the school, reflective dialogue, and instructional leadership. Perception of competition was chosen given the significant effect perceived competition had on the influence of social connections. Perceived competition could also influence performance and the literature on competition and performance on complex tasks suggests a negative effect (Ariely et al., 2005; Pink, 2009). Reflective dialogue has been shown to be an important predictor of teacher performance by several scholars, most convincingly by Leana and Pil (2006). Instructional leadership was also included in the model given the significant impact principal leadership with regard to instructional content knowledge can have on teacher performance (Blase and Blase, 2004; Bryk et al., 2010; Heck et al., 1990; Marks and Printy, 2003). The third model consisted of the demographic attributes, the survey measures of competition, reflective dialogue, and instructional leadership, and the social capital measures. The fourth model combined all measures.

Table 30: Predicting Reading Teacher Value-Added Scores

	Model 1	Model 2		Model 3		Model 4	
(Intercept)	-0.7098	-6.0899	*	-3.0097		-3.9072	
EDUC	0.8570	1.1891		1.5578	*	1.3375	
SEXM	1.4679	1.5021		1.8776		1.6729	
YRSDIST	-0.0387	-0.0656		-0.0646		-0.0617	
RACE	-0.2461	-1.2984		-2.3743		-3.2411	
EFFIC_SE		0.8613				0.8685	
EFFIC_CM		0.2596				-0.1245	
EFFIC_IS		0.4698				0.5863	
SCMT_PROF		-0.5940				-0.4347	
SCMT_ORG		-0.9287				-1.5465	
COMP		0.7638	**	0.3730		0.6302	
REFD		1.1633	*	1.0836	*	1.3924	*
INST		0.1882		-0.5983		-0.4637	
SC_EFFIC_SE				-0.1372		-0.1285	
SC_EFFIC_CM				0.1150		0.1041	
SC_EFFIC_IS				0.0410		0.0265	
SC_SCMT_PROF				-0.0421		-0.0021	
SC_SCMT_ORG				0.1684	*	0.2131	*
R-Squared	0.018	0.135		0.209		0.248	
N	90	87		85		85	

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

Model 1 indicated that none of the demographic attributes were a significant predictor of a teacher's reading value-added score. When the survey variables were added in Model 2, competition and reflective dialogue were significant predictors. Specifically, school teachers who perceived lower levels of competition among their peers tended to have higher value-added scores (recall that the COMP variable is scaled so that larger number represent lower competition) supporting the growing literature indicating the competition can thwart performance (Pink, 2009). While previous research has only linked *school-level* collaboration to *school-level* performance, Model 2 revealed that reflective dialogue had a positive influence on *individual* teacher performance.

Model 3 removed the individual efficacy and commitment variables from the model and replaced them with social capital measures. Again, these social capital variables capture the level of resources available to a teacher through his or her social network. Reflective dialogue was still a significant predictor, but now education was also significant. Of the social capital variables, the commitment of one's social connections to the organization had a positive and significant influence. Perhaps the most interesting finding when moving from Model 2 to Model 3, was that the R-squared increased by 55% indicating that the efficacy and commitment of a teacher's peers was a more important predictor of that teacher's value-added then the teacher's own efficacy and commitment.

When all of the variable were added into the model, reflective dialogue and peer organizational commitment remain significant predictors. Thus, even when controlling for personal efficacy and commitment, peer organizational commitment was a positive and significant predictor of value-added. Results for the math value-added are shown below in Table 31.

Table 31: Predicting Math Teacher Value-Added Scores

	Model 1		Model 2		Model 3		Model 4	
(Intercept)	-2.0905		-4.9509		-0.8785		-2.10604	
EDUC	1.7457		2.1810	*	1.7384		1.845544	
SEXM	-0.9862		-0.6732		-1.6460		-1.55916	
YRSDIST	-0.1013		-0.0727		-0.0097		-0.00874	
RACE	0.6510		1.2723		-2.9279		-1.47337	
EFFIC_SE			-0.4998				-0.87272	
EFFIC_CM			1.8872	*			1.444321	
EFFIC_IS			-0.0674				0.033198	
SCMT_PROF			-0.8883				-0.53438	
SCMT_ORG			0.5103				-0.61603	
COMP			0.1154		0.0962		0.06504	
REFD			1.1350		1.8247	**	1.7875	*
INST			-0.7318		-1.8459	*	-1.3912	
SC_EFFIC_SE					0.0762		0.069478	
SC_EFFIC_CM					-0.0245		-0.05989	
SC_EFFIC_IS					-0.0365		-0.07906	
SC_SCMT_PROF					0.1204		0.102931	
SC_SCMT_ORG					0.2413	*	0.255704	*
R-Squared	0.036		0.159		0.173		0.2072	
N	82		79		77		77	

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level

Similarly to reading value-added, the effect of demographic attributes on math performance were insignificant. When the survey items were included in Model 2, both education and classroom management efficacy were significant predictors. Moving from individual measures of efficacy and commitment to peer measures, reflective dialogue, instructional leadership, and peer organizational commitment were all significant predictors. While reflective dialogue and peer organizational commitment were in the direction hypothesized, instructional leadership had a negative effect. However, this effect was no longer significant in the fourth model.

The significant effects in Model 4 were identical to those found for reading value-added. Both reflective dialogue and peer organizational commitment were significant and positive predictors of math value-added. It should be noted that once again peer efficacy and commitment (Model 3) more strongly predicted value-added than self efficacy and commitment (Model 2) though the increase in predictive power was much smaller for math value-added than for reading.

7.1.4 Summary

One of the issues confronting theoretical developments of social capital is the manner by which social structure leads to improved outcomes. As discussed earlier, several theorists, such as Burt (1992) argue that social capital, especially in organizations, arises through individually beneficial structural positions. Conversely, scholars like Putnam (2000) and others, contend that social capital is a product of cohesion within a group. The results above lend support to both conclusions. Social capital at the individual level, as measured by the organizational commitment of a teacher's social connections, and social capital at the group level as measured by the reflective dialogue in the school, both had positive and significant effects on a teacher's value added performance.

The cross-sectional nature of the dataset is a limiting factor in generating a causal understanding of how individual level and school level variables influence teacher performance. The most appropriate, and policy relevant question, is how can we increase teacher and school value-added. The current value-added measures, while based on longitudinal student data, simply indicated a current level of teacher performance and not a growth in performance. Ideally, one would track teacher value-added over several years and investigate how changes in

value-added across teachers relate to factors associated with collaboration, centrality, and social capital.

Teachers enter schools with an intrinsic capacity to teach; that capacity appears to be altered by interactions with peers, school climate, and classroom dynamics. The objective for future research must be to understand the ways in which policy can create environments and interactions that impart a positive effect on teacher capacity to perform. Based on the results above, social connections to coworkers with high commitment to the school appear to be an important social factor in performance. Not only does peer organizational commitment influence self organizational commitment, it also has a positive influence on performance.

Lastly, while none of the models produced impressive predictive results, the fact that the efficacy and commitment of one's peers (Model 3) had a greater predictive capacity for value-added than one's own efficacy and commitment (Model 2) is noteworthy.

8.0 MODELING NETWORKS

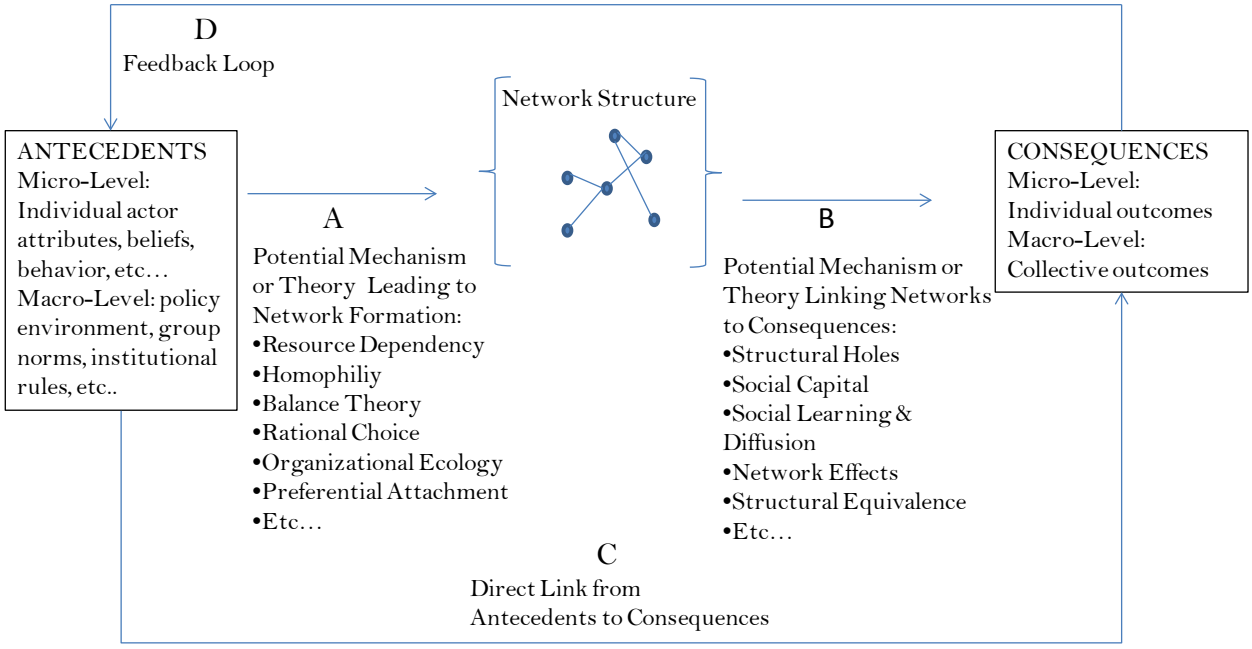
Developing methods and models to assess the causal impact of networks is an ongoing and critical focus of network scholars. To date, nearly all network research has been associational and not causal. This study also suffers from a lack of causal claims, though modest attempts were made to limit the threat of selection. Data limitations, especially the lack of longitudinal data, did not allow for causal modeling, but the research design and data collection procedures utilizing the role repertory grid offer an approach to develop and support more sophisticated analysis.

Based on the work of Shalizi and Thomas (2010), it is clear that homophily and contagion (network effects) cannot be separated unless we understand the processes that generated the network in the first place. A primary limitation of network research in general, has been the lack of cognitive factors in antecedent models leading to an incomplete understanding of the generative processes of network formation. The use of the role repertory grid to elicit the relevant personality traits and constructs that comprise the various facets of interpersonal perception offers a promising approach to understand the cognitive component in network formation.

Returning to our original framework, the perception of an actor by his peers along these relevant traits allows a researcher to assess how individual attributes contribute both to network

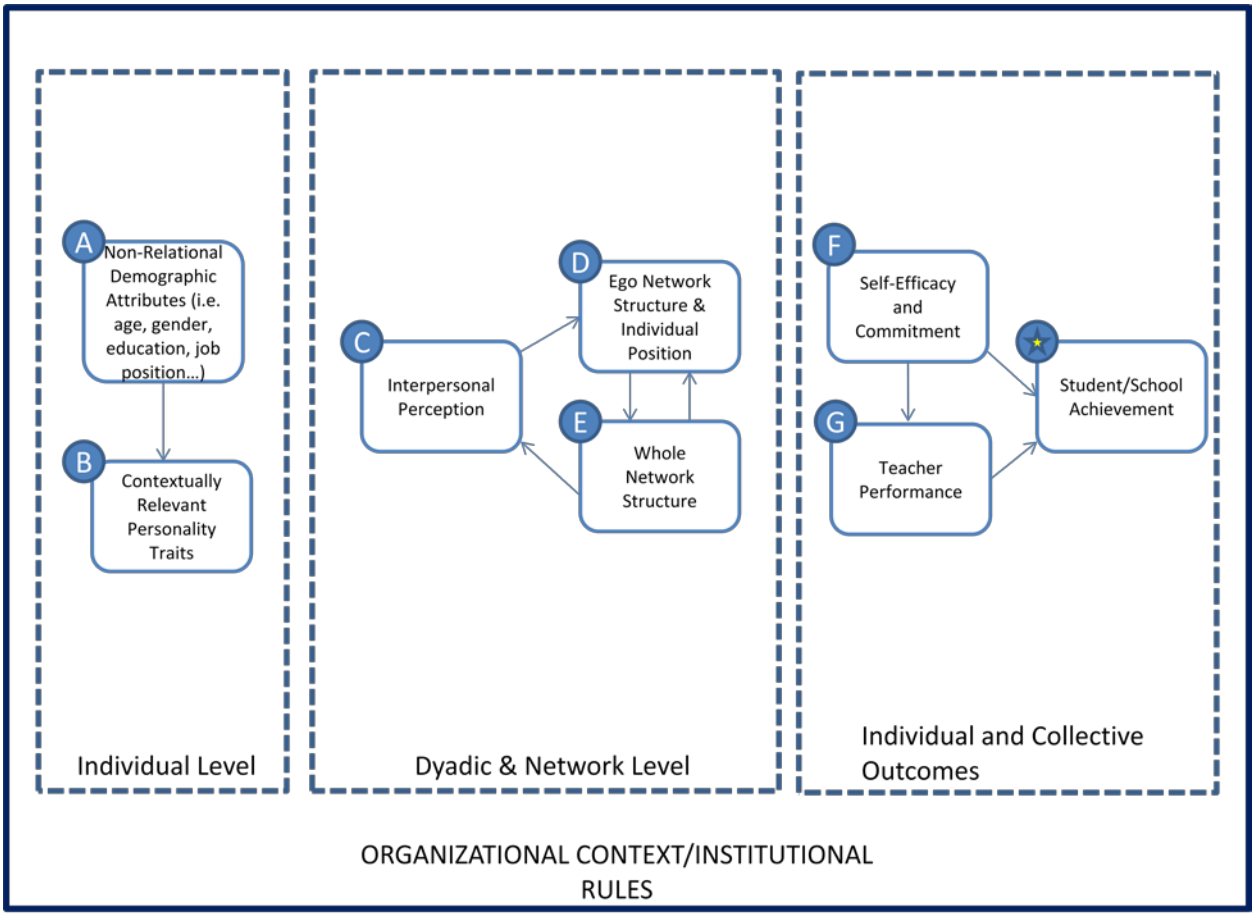
position and to certain outcomes. Understanding these connections can aid in the isolation of the effect of network position and structure on individual and collective outcomes.

Figure 30: Multilevel Network Framework



A more detailed diagram of the relationships discussed in this study are shown below in Figure 31. This diagram provides additional insight into the multilevel framework and allows for the identification of important pathways leading to the outcome of interest - teacher performance and student learning. Figure 31 is broken down into three sections, individual level, network level, and outcomes. Within each section pathways between variables are presented, however, the myriad of potential pathways connecting variables across the levels are not shown. Rather a discussion of the methodology researchers have employed to assess different pathways is provided.

Figure 31: Linking Individual Attributes, Networks, and Outcomes



The first section, the individual level, contains variable sets A and B, which are an actor's attributes and personality traits. These variables are assumed to be fixed in the short term. The second section contains variables concerning dyadic data and network level variables. Here the variable sets concern interpersonal perception of peers in the organizational environment, the structure of an individual's network, and overall network structure. These sets are strongly interrelated. As learned from the work of the social psychologists, ego's interpersonal perception of the alter's in the network is a key driver of social behavior. This behavior shapes ego's particular network which influences the entire organizational social structure. The organizational

structure itself can, overtime, influence interpersonal perceptions, as one may begin to see friends or even friends of friends in a more positive light. Individuals may also tend to form closed triangles and thus the formation of new ties may begin to alter previously held perceptions. Lastly, the third section highlights individual and organizational outcomes. With regard to teachers, the outcomes of interest were efficacy, commitment, and performance. The critical research goal is not only to understand how variation in outcomes arise but to ultimately design policies to improve those outcomes. Given the wide variety of variable sets contained in Figure 31, researchers have approached their interaction using multiple methodologies.

One of the most common ways network variables have been used to assess performance is through the use of standard econometric tools (this approach was used with the multilevel models of Chapter 6 and OLS models of Chapter 7). These tools rely on individual network variables, such as centrality to predict variation in outcomes. This approach most commonly uses variable sets A, B, and D to predict G. The specific variables from the network level set D tend to be individual measures of centrality, brokerage, or constraint. An classic example of this approach can be seen in the work of Burt (1992). A potential problem with this approach is that it ignores two key processes: (i) how an individual arrived at his or her position of centrality or brokerage, and (ii) how the attributes of the alters the individual is connected to influence the outcome of interest. As previously described, it is possible that the same attributes or attitudes that lead an individual to a more structurally advantageous position are the same factors leading to improved outcomes. Thus, significant findings for network variables may be spurious. Furthermore, attitudes and beliefs are socially influenced and thus the effect of peer attributes on outcomes need to be considered. If one is interested in estimating the peer effects on an

individually measured outcome, network autocorrelation models can be used with cross-sectional data (this approach was used in the latter half of Chapter 6).

When the network itself is the outcome of interest, exponential random graph models and MRQAP models can be used to link variable sets A and B with E. Here the primary emphasis is on understanding the factors that led to the observed network. If network and actor data are available at two or more time points, then the actor-based models of Tom Snijders (Ripley et al., 2012; Snijders, 2005; Snijders et al., 2010; Steglich et al., 2010) and the Siena application can be used to examine the evolution of the network. These models estimate both a selection function and an influence function to understand how these factors jointly effect the evolution of network structure and therefore network data from at least two time points is necessary.

Many network researchers are interested in not only modeling the evolution of the network but the evolution of a particular behavior or attitude that is believed to be related to network structure. In such coevolutionary models, network structure and behavioral responses at each time point influence network structure and responses at the following time point. For instance, the study by Steglich et al. (2010) analyzed how adolescent social networks and substance use interacted overtime. Based on Figure 31, these research questions examine the co-evolution of E and F and use variable sets A and B as predictors of changes in both the network outcome and the behavioral outcome while simultaneously assessing how changes in E influence F and vice versa.

Finally, when data is available on multiple networks, the processes discussed in Figure 31 can be viewed as occurring in the multiple organizations or social structures of interest. When longitudinal data on several networks are available, one can engage in meta-analysis to synthesize the results found across the different contexts. This approach improves

generalizability and statistical power and offers the most promising approach for understanding how networks effect both individual and collective outcomes. See (Ripley et al., 2012) for an example and discussion.

In all of the potential modeling strategies discussed above, the role of interpersonal perception, variable set C, has not been taken into account. Studies employing ERGMs and actor based models have generally failed to account for the role of psychological/personality factors in network formation. Given an observed graph or set of observed graphs it is assumed that an individual's probability of forming a tie with any member of the network is simply a function of structural tendencies present in the graph and a set of demographic attributes. For instance, Goodreau et al. (2009) modeled school network selection based on student sex, age, grade level, etc... Based on the data available, it was not possible for Goodreau et al. to account for how interpersonal perception influenced the likelihood of the tie. As identified in the network antecedent models of Chapter 5, the cognitive factors were important determinants of social structure. These factors were key variables in the selection process and should be identified and, when possible, explicitly modeled in studies investigating network formation and network consequences.

The research design developed in this study offers a coherent and contextually grounded approach to the identification and measurement of the relevant personality and cognitive traits of the actors in the network. By capturing demographic, structural, and psychological factors associated with network formation one can develop stronger causal arguments given the improved knowledge of the variables that led to the observed structure.

9.0 CONCLUSIONS AND POLICY IMPLICATIONS

9.1 REVISITING THE FIVE RESEARCH OBJECTIVES

This study began by positing five limitations of organizational network research and outlining five research objectives. The first research objective was to discover the key personality traits and frames of reference on which organizational actors rely when comparing their coworkers. The second objective was to statistically model how interpersonal perception along these salient personality traits affected relational tie formation and overall network structure within an organization. These objectives directly addressed the ongoing limitation in network research that ignores personality and cognition in network formation (Kadushin 2012). The role repertory grid was used to elicit the relevant traits/cognitive constructs from teachers. These traits then became predictors in network antecedent models and were shown to have significant effects in predicting friendship and advice ties. Based on the MRQAP models, interpersonal perception on the Amity Factor was a key dyadic predictor of friendship tie formation. For advice tie formation, the Trust Factor was the key dyadic predictor, while the Work and Amity Factors were also significant. The results highlight a need to include psychological factors to produce stronger and more theoretically grounded antecedent models.

The MRQAP models in Chapter 5 of teacher social networks offer one potential explanation as to why learning communities in some schools fail to produce intended results.

Teachers need to have a base level of trust and respect for their coworkers if they are to engage in knowledge sharing and dialogue meaningful for classroom instruction. Simply setting time aside for teachers to collaborate can, under certain conditions, lead to contrived collegiality (Hargreaves, 1994), limiting the benefits of teacher interaction.

The third objective sought to increase our understanding of both individual network and group network structure on outcomes. The multilevel models of efficacy and commitment contained both individual level network variables and group level network variables as predictors. The results offered only partial support for the hypothesis that both individual level and group level network variables would have a positive effect on efficacy and commitment. The multilevel models were followed by network autocorrelation models that considered how alter attitude and beliefs influence ego's attitude and beliefs. This work clarified the limited role of networks in the multilevel models by highlighting the importance of the attributes of one's alters. In addition, it addressed part of objective 4 by investigating how different networks (e.g., advice and friendship) may have different impacts on various outcomes. For student engagement, classroom management, and instructional strategy efficacy as well as for organizational commitment the network autocorrelation models revealed that in the advice network teachers are positively influenced by the efficacy and commitment beliefs of their peers. Specifically, holding other factors constant, an increase in alter's efficacy and commitment increased ego's efficacy and commitment. For friendship networks, the influence of one's alters was reversed, having alter's with higher values on the response variable tended to reduce the teacher's own outcome.

These findings were further analyzed by looking at how group level variables predicted the influence of network structure in schools. In line with objective 3 and the role of

organizational factors on networks and individual outcomes, it was found that schools with higher levels of competition among the teachers tended to have social structures that had a negative influence on teacher efficacy and commitment. Thus, not only did the pooled friendship and advice network effects indicate different influences on teacher behavior, the variation that did exist across the schools could be partly explained by a school-level measure of competition.

The fourth objective also concerned social capital theory and the fifth objective was directly focused on individual performance. A measure of social capital available to a teacher was calculated based on the number of connections, the strength of connections, and the resources available through those connections. This straightforward measure offers an improvement upon previous work that relied on either teacher reports of school trust and dialogue or a simple centrality score to estimate social capital.

Unlike nearly all other complex organizational settings, performance in schools can be measured objectively and quantitatively. Value-added models of teacher performance were built to measure the gain in student test scores that could be attributed to a particular teacher. The results of standard OLS models showed that two variables were significant and positive predictors of both math and reading value added. The first, was a teacher's perception of reflective dialogue in a school. The more a teacher saw coworkers engaged in collective discussions about teaching and student learning the higher the teacher's value-added score. This variable captures the cohesiveness of a school and can be seen as a measure of collective social capital akin to the work of Putnam. The second variable, the organizational commitment of a teacher's alters offered a different view on social capital as it was measured based on the connections each individual teacher held. Teachers who were more active and formed

connections to teachers with higher levels of organizational commitment tended to have higher levels of social capital in the network. This measure of social capital was a positive and significant predictor of teacher performance. Thus, both an individual measure and a collective measure of social capital in a school were important predictors of value-added scores.

All of the findings, while provocative, are merely suggestive of important relationships demanding further investigation. The research offers no strong causal claims and simply lends support and, in some instances, new light on the critical linkages between social structure and individual and organizational outcomes.

9.2 CONCLUSIONS FOR EDUCATION POLICY

Beyond addressing the five limitations facing the broad area of organizational network research, this study carries important policy implications for the education sector. Firstly, it supports school and school districts' attempts to establish professional learning communities. There is a great deal of tacit knowledge and expertise currently residing in schools that can be capitalized on by linking teachers together to share and disseminate pedagogical ideas and lessons learned. However, within this same context, state and predominately federal level education policy is pushing for greater levels of competition among teachers. These two forces are in conflict with each other. Competition was shown to alter the value of teacher collaboration in schools. Looking at the forest plots resulting from the network autocorrelation models, there are several instances of significantly negative network effects in both the advice and friendship networks. These instances are examples of when social connections carry unconstructive knowledge and information. A determining factor for why certain schools had

negative network effects was the perceived competition among teachers in the school. Thus, in competitive environments, the value of peer collaboration and interaction may be reduced and in some instances result in harmful effects.

These findings suggest the need for education reformers to reconsider their demand for greater levels of competition among teachers. In February of 2012, New York City Schools released value-added scores for some 18,000 teachers in the district. The public display of performance measures that offer only shame to low performers and praise to high performers does nothing to alter the instructional capacity in a school. By publically ranking and comparing teachers an increased sense of competition with one's peers is inevitable and this perception can have severe an unwanted impacts on individual and collective outcomes. Some demand performance measures be used to punish those who do not perform well, even proposing to fire the bottom 5%.

These tactics may be harming the profession. This harm comes in several forms. Firstly, based on the research findings presented above, teachers who work in schools with greater levels of competition develop potentially harmful social structures. Secondly, as policy changes alter the teaching profession through competitive incentives and threats, such changes may be partly responsible for plummeting teacher commitment. The most recent MetLife Survey of the American Teacher (2011) found that in the past two years that the percentage of teachers who were very satisfied with their jobs dropped from 59% to 44%. Similarly, the number of teachers who indicated they were considering changing professions rose from 17% to 29%. Thus, in just two years the number of teachers contemplating leaving the profession nearly doubled. The evidence provided by the MetLife survey perfectly aligns with the ongoing problems of teacher

retention. As highlighted earlier, nearly 46% of teachers leave the profession in the first five years costing the educational system some $7 billon (NCTAF 2007).

These retention and satisfaction figures should give pause to the continued pursuit of high-stakes teacher evaluation policies. The goals of value-added models and data driven assessments need to be redirected. Rather than being used to determine firings and salary, they should be used to identify and help poorly performing teachers, pair low-performers with potential mentors, and as a means to better understand what works at the classroom, school, and district level.

In the coming years more schools are developing performance systems that emphasize teacher performance as measured by student test scores. School districts in Ohio will begin using value-added ratings in 2013 and Florida will do the same in 2014. In other states, like New York, teacher value-added scores already account for 25% or more of a teacher's complete evaluation. As the drive for performance measures continues, it is crucial that districts use these measures to drive collaboration and not competition. Value-added measures can be helpful policy indicators of what works, especially if used in large-scale policy studies. Value-added measures can also be tactless weapons of competition. There is a fine line that must be walked when districts seek to develop and use these measures. Evidence suggests that pay for performance works in settings where the tasks are simple and routine. Thus, paying individuals for piecemeal work rather than hourly wages can improve productivity (Lazear, 2000). However, in most other organizational situations, where task are more complex and less mechanistic, rewards have been shown to reduce creativity, productivity, and satisfaction (Ariely et al., 2005; Pink, 2009).

When Frederick Taylor was establishing his theories of scientific management to improve the productivity of workers, his theory was applicable to the factory lines and assembly stations he researched. But in modern day organizations, where complex and evolving problems are confronted, workers do not respond to competition and performance incentives in the same manner (Pink, 2009). Research has shown that the introduction of monetary rewards for performance tasks that involve problem solving resulted in reducing performance rather than improving it (Ariely et al., 2005). One of the mechanisms driving the negative relationship between monetary rewards and problem solving capacity is a narrowing of attention to smaller and often singular aspects of the task (Easterbrook, 1959). For school teachers this means focusing only on aspects of instructional strategy that relate to standardized tests. This emphasis on teaching to the test rather than more holistic and in-depth learning may ultimately lead to a reduction in student education.

Despite a body of scientific evidence that indicates competition ultimately reduces performance, the belief that competition leads to improved outcomes pervades the public and private sector. The Teacher Incentive Fund of the Obama Administration, which supports merit pay efforts, is built on the assumption that the incentive to earn additional money will motivate teachers to adopt more effective teaching strategies and work harder to improve student outcomes (Berry and Eckert 2012). Evidence from K-12 studies of pay for performance counter the beliefs of the Teacher Incentive Fund. A study by the National Center of Performance Initiatives found that bonuses offered to math teachers that ranged from $5,000 to $15,000 produced little to no student achievement gains compared to teachers who received no monetary incentives (Berry and Eckert 2012). In fact, Frank et al. (2010) discuss how recent findings have shown that "teachers listed support from leadership and opportunities to collaborate as more

important for retaining good teachers than factors associated with salary" (p. 229). The key message for districts pushing ahead with performance measurement systems is to use them to improve collaboration and to build an information base of what works in their schools. Using the data to identify, either publically or within the school, poor performers and to begin paying teachers based on value-added performance may lead to negative impacts.

Anecdotal evidence from a recent conversation with an elementary public school teacher strongly supports these conclusions. At the beginning of the year she described the strong collaboration that existed between the members of her 4th grade team. The level of help and support displayed within the group yielded them the moniker "Team of Love". When testing season began after the holiday day break, the pressure for teachers to perform consistently increased up until the week the standardized exams were given. This year, in particular, teachers were strongly challenged by the principal to achieve high growth and to outperform their coworkers. The pressure ultimately divided the previously highly collaborative "Team of Love". Two of the more veteran teachers stopped sharing ideas with the other members and partnered with each other on reteaching/enriching exercises without letting the other team members know. The two veteran teachers also implemented motivational tactics and test-taking lessons from the past years without offering any of the material to the rest of the team or to any of their peers. One of the veteran teachers then continuously tried to bring in the sole 4th grade assistant assigned to the team to aid only her class.

At grade level and school meetings many inappropriate and highly competitive comments were made such as "your kids won't pass the exams", "your kids won't score as high as my kids", "I had the second highest growth in the school last year, and I'm getting first this year". The

environment of the school changed and many teachers felt like they no longer wanted to work in such a culture.

This 4th grade teacher's story highlights the value of social connections among teachers in schools and the detrimental effects of heightened competition. What is frightening is that this school has not yet developed a pay for performance program...that program goes into effect in two years. The teacher stated that she is afraid to think about the type of culture and competition that will arise when salaries are attached to student test scores and the negative impact it will ultimately have on both teachers and students.

9.3 NEXT STEPS

The results of the network consequence models underscore the fact that teacher social networks are an important component of schools as organizations. Social networks were shown to influence teacher efficacy, commitment, and performance. The antecedent models offered insight into the factors driving network formation and the important role of trust in advice networks. Moving beyond these findings, research on the social organization of schools needs to develop longitudinal datasets to track the co-evolution of network structure and teacher attitudes and performance. In addition to gathering more waves of data, a greater number of schools need to be involved to increase statistical power and to develop more rigorous causal models.

Given the demands of network data collection and the interdisciplinary nature of the pursuit, the development of a national center for networked education studies could provide the tools and manpower needed to more fully understand the critical link between social networks and educational outcomes. The networks under study could range from student networks, to

teacher networks, to inter-organizational networks linking schools with community based organizations. This center would ideally include researchers interested in youth behavior who could study how networks influence obesity, smoking, alcohol use and sexual relationships. Research along these lines is currently underway by several scholars using the now famous Add Health dataset. Methodological scholars could also be involved to continue the development and refinement of multilevel network models that can capture network structure at the student, teacher, and potentially school level within a single model. Recent developments in multilevel modeling appear promising and in June of 2012, the University of Manchester hosted an international symposium on the current state of multilevel network modeling. These models would, for the first time, provide insights into how the social structure of a teacher in a school influences the types of social structures that emerge among the students in his or her classroom.

Other promising avenues of study include the use of experimental designs to assess the potential for policy to influence network structure. As noted in the MRQAP models, trust was a strong predictor of whether two teachers form an advice tie. Based on this finding, school districts could offer certain professional development courses aimed at improving trust in the workplace. The ability of a development course to garner trust and ultimately influence teacher collaboration could easily be studied through an experimental design involving several schools which receive the development course and others which do not. Measuring and mapping how social networks evolve after the trust development course would provide information on at least one of the social mechanisms at work driving collaboration and improving social capital. Other options include developing courses specifically designed to help teachers recognize and access their social capital (Baker-Doyle and Yoon, 2010). Lastly, tracking new teachers as they enter a school for the first time would provide a wealth of information on how individuals become a part

of the social organization of a school and the role social connections play on efficacy, commitment, and performance over time. Tracking new teachers would help identify factors associated with teacher retention and job satisfaction.

As research has shown, teacher interaction and collaboration through social networks can be powerful predictors of school success. Research on both the consequences and antecedents of social structure in schools should continue with an emphasis on the causal mechanisms by which social networks emerge, transfer knowledge and support, and result in greater levels of individual and organizational success.

APPENDIX A

BIVARIATE CORRELATIONS BETWEEN THE 11 TRAITS AND THE NETWORKS

To test the relationship between each trait and each network relation within a school, bivariate QAP analysis was used. In this simple analysis each trait was incorporated as a single predictor of network behavior. Thus, for each school, 22 different bivariate regressions were run (11 traits for 2 networks).

Table 32: Bivariate Correlations

		Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
NETWORK	TRAIT	*B*	*r*	*B*	*r*	*B*	*r*	*B*	*r*	*B*	*r*	*B*	*r*
Friendship	Caring	0.214*	0.164	0.472	0.330	0.268**	0.358	0.226*	0.261	0.1377	0.095	0.201	0.158
Advice	Caring	0.283**	0.266	0.037	0.032	0.313**	0.374	0.139	0.126	0.108	0.077	0.251**	0.243
Friendship	Collaborative	0.245**	0.197	0.629**	0.474	0.242**	0.315	0.174*	0.235	-0.018	0.000	0.313**	0.232
Advice	Collaborative	0.230***	0.298	0.057	0.032	0.283**	0.329	0.216	0.230	0.052	0.045	0.424***	0.386
Friendship	Approachable	0.227*	0.179	0.548**	0.385	0.238**	0.308	0.296*	0.311	0.263*	0.187	0.268**	0.226
Advice	Approachable	0.349***	0.338	0.306	0.190	0.184	0.212	0.207	0.187	0.312**	0.235	0.342***	0.352
Friendship	Competent	0.156	0.105	0.518*	0.322	0.345***	0.435	0.186	0.197	0.256*	0.145	0.128	0.089
Advice	Competent	0.369***	0.308	0.056	0.032	0.417***	0.470	-0.004	0.000	0.205	0.122	0.473***	0.401
Friendship	Flexible	0.256***	0.205	0.466**	0.377	0.168*	0.214	0.231	0.247	0.244**	0.190	0.152	0.148
Advice	Flexible	0.286***	0.281	0.247	0.176	0.106	0.122	0.200	0.170	0.215**	0.184	0.200	0.239
Friendship	Good Listener	0.258**	0.200	0.501*	0.417	0.160	0.210	0.228	0.228	0.233	0.160	0.203*	0.164
Advice	Good Listener	0.381***	0.363	0.215	0.158	0.243*	0.283	0.123	0.100	0.354***	0.259	0.304***	0.300
Friendship	Hardworking	0.164	0.110	0.012	0.000	0.341**	0.385	0.249*	0.303	-0.011	0.000	0.282*	0.190
Advice	Hardworking	0.333***	0.272	-0.282	0.155	0.375**	0.378	0.229	0.221	0.194	0.122	0.524***	0.435
Friendship	Modest	0.182*	0.141	0.395	0.277	0.333***	0.373	0.158	0.158	-0.007	0.000	0.083	0.071
Advice	Modest	0.330***	0.316	0.011	0.000	0.337**	0.338	0.088	0.071	-0.033	0.032	0.284***	0.286
Friendship	Open Minded	0.182*	0.152	0.502*	0.401	0.126	0.170	0.189	0.239	0.027	0.000	0.087	0.084
Advice	Open Minded	0.260***	0.265	0.186	0.130	0.099	0.118	0.151	0.152	0.078	0.055	0.177**	0.207
Friendship	Positive	0.210*	0.158	0.535*	0.382	0.122	0.173	0.227	0.297	0.262*	0.187	0.271**	0.247
Advice	Positive	0.278***	0.261	0.266	0.167	0.101	0.126	0.221	0.230	0.285**	0.219	0.354***	0.397
Friendship	Trustworthy	0.143	0.114	0.538*	0.370	0.254**	0.355	0.191	0.232	0.191	0.145	0.157	0.110
Advice	Trustworthy	0.307***	0.297	0.415	0.251	0.344***	0.430	0.034	0.032	0.264**	0.212	0.335***	0.293

*** - significant at .01 level; **-significant at .05 level; *significant at .10 level; all significance tests are one tailed

The correlations between network variables and non-network variables may appear smaller than expected. However, due to the structure of network data, there are limits to the possible correlations between network matrices and non-network data matrices (Krackhardt 1988; Gibbons and Olk 2003). For friendship, the traits with the strongest evidence of influencing tie formation are collaborative (significant in five sites), approachable (significant in six sites), flexible (significant in four sites), and positive (significant in four sites). With regard to advice seeking, the traits with the strongest evidence are good listener (significant in four sites) and trustworthy (significant in four sites). While the other traits were shown to be important predictors in several of the sites for both friendship and advice seeking, the results based on these simple tabulations have face validity. For instance, one would expect teachers to seek advice from those who are capable of listening to their problems and from those who they trust enough to ask for help. Similarly, friendship would mostly likely emerge between a teacher and a coworker perceived to be positive and approachable.

APPENDIX B

SURVEY DOCUMENTATION

As specifically noted in Chapter 3, many of the questions in these surveys came from The University of Chicago Consortium on Chicago School Research. For more information and documentation on their surveys go to http://ccsr.uchicago.edu/.

B.1 TEACHER SURVEY

1.) Please mark the extent to which you agree with each of the following:

	Not at all	A Little	Some Degree	Quite a Bit	A Great Deal
Teachers talk about instruction in the teachers' lounge, faculty meetings, etc.	( )	( )	( )	( )	( )
Teachers in this school share and discuss student work with other teachers	( )	( )	( )	( )	( )
Experienced teachers invite new teachers into their rooms to observe, give feedback, etc.	( )	( )	( )	( )	( )
A conscious effort is made by faculty to make new teachers feel welcome	( )	( )	( )	( )	( )
All teachers are encouraged to stretch and grow	( )	( )	( )	( )	( )
In this school, teachers are continually learning and seeking new ideas	( )	( )	( )	( )	( )

2.) This school year, how often have you:

	Never	Once or Twice	3 to 9 Times	10 or More Times
Observed another teacher's classroom to offer feedback	( )	( )	( )	( )
Observed another teacher's classroom to get ideas for your own instruction	( )	( )	( )	( )
Gone over student assessment data with other teachers to make instructional decisions	( )	( )	( )	( )
Worked with other teachers to develop materials or activities for particular classes	( )	( )	( )	( )
Worked on instructional strategies with other teachers	( )	( )	( )	( )

3.) This school year, how often have you had conversations with colleagues about:

	Less than Once a Month	2 or 3 Times a Month	Once or Twice a Week	Almost Daily
What helps students learn the best	( )	( )	( )	( )
Development of new curriculum	( )	( )	( )	( )
The goals of this school	( )	( )	( )	( )
Managing classroom behavior	( )	( )	( )	( )

4.) To what extent do you feel respected by:

	Not at All	A Little	Some	To a Great Extent
Your principal	( )	( )	( )	( )
Other teachers	( )	( )	( )	( )
The parents of your students	( )	( )	( )	( )

5.) How many teachers in this school:

	None	Some	About Half	Most	Nearly all
Help maintain discipline in the entire school, not just their classroom	( )	( )	( )	( )	( )
Take responsibility for improving the school	( )	( )	( )	( )	( )
Feel responsible to help each other do their best	( )	( )	( )	( )	( )
Feel responsible that all students learn	( )	( )	( )	( )	( )
Feel responsible when students in this school fail	( )	( )	( )	( )	( )
Are really trying to improve their teaching	( )	( )	( )	( )	( )
Are willing to take risks to make this school better	( )	( )	( )	( )	( )
Are eager to try new ideas	( )	( )	( )	( )	( )

6.) How much influence do teachers have over school policy in each of the areas below:

	None	A Little	Some	To A Great Extent
Hiring new professional personnel	( )	( )	( )	( )
Planning how discretionary school funds should be used	( )	( )	( )	( )
Determining books and other instructional materials used in classrooms	( )	( )	( )	( )
Establishing the curriculum and instructional program	( )	( )	( )	( )
Determining the content of in-service programs	( )	( )	( )	( )
Setting standards for student behavior	( )	( )	( )	( )

Networks in Schools

Informal and professional relationships exist in organizations of all types. This set of questions will ask you to reflect on various relations formed within your school. These questions will provide you with a list of teachers and other staff members. A few of these people you may interact with quite frequently, while others you may not interact with at all. In the next three sets of questions we are interested in understanding with whom you interact and the frequency or strength of those interactions. Please note that your name will appear on the list. You can simply skip the row containing your name.

7.) Please indicate the members of the school below with whom you are friends. These are people with whom you like to spend your free time, people with whom you plan to go to dinner, visit each other's homes, attend concerts or other social events. For individuals you consider to be friends in this regard, please indicate the level of friendship. For all other individuals simply check the box indicating that you are "Just Coworkers". So, if you feel you have one friend within your school environment then choose the level of friendship for that person and for all other individuals check the box for "Just Coworkers".

	Just Coworkers	Slight Friends	Fairly Good Friends	Close Friends	Especially Close Friends
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

8.) The previous question concerned whom you are friends with in the school. This question is directed at information and knowledge exchange. Please indicate on the list below which co-workers <u>you seek out or go to for advice</u>. Work related advice may concern information on ways to strengthen practice, ideas on teaching style, lesson planning, classroom management, or for other work related reasons. For those that <u>you seek out or go to for advice</u> please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

9.) The previous question asked about coworkers you sought out for advice. This question now asks which coworkers <u>come to you for advice</u>. With regards to individuals <u>who come to you for advice</u>, please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

10.) Which of the following teachers do you consider to be informal leaders in the school? An informal leader may be someone other teachers look up to and, while not holding an official position of power, have the capacity to influence or lead others. Please select all that apply.

[ ] Teacher 1

[ ] Teacher 2

[ ] Teacher 3

[ ] Teacher 4

[ ] .

[ ] .

[ ] .

[ ] Teacher n

11.) The following list of questions is designed to help us gain a better understanding of the kinds of things that create difficulties for teachers in their school activities. Please indicate your opinion about each of the statements below.

	Nothing	Very Little	Some	Quite a Bit	A Great Deal
How much can you do to control disruptive behavior in the classroom?	( )	( )	( )	( )	( )
How much can you do to motivate students who show low interest in school work?	( )	( )	( )	( )	( )
How much can you do to get students to believe they can do well in school work?	( )	( )	( )	( )	( )
How much can you do to help your students value learning?	( )	( )	( )	( )	( )
To what extent can you craft good questions for your students?	( )	( )	( )	( )	( )
How much can you do to get children to follow classroom rules?	( )	( )	( )	( )	( )
How much can you do to calm a student who is disruptive or noisy?	( )	( )	( )	( )	( )
How much can you use a variety of assessment strategies?	( )	( )	( )	( )	( )
To what extent can you provide an alternative explanation or example when students are confused?	( )	( )	( )	( )	( )

12.) Please indicate the extent to which you agree with the following statements:

	I Do Not Agree	I Agree Slightly	I Agree Somewhat	I Agree Quite a Bit	I Completely Agree
I put in a great deal of effort beyond what is normally expected in order to help this school be successful	( )	( )	( )	( )	( )
I usually look forward to each working day at this school	( )	( )	( )	( )	( )
I wouldn't want to work in any other school	( )	( )	( )	( )	( )
I would recommend this school to parents seeking a place for their child	( )	( )	( )	( )	( )
I do not seem to have as much enthusiasm now as I did when I began teaching	( )	( )	( )	( )	( )
If I could get a higher paying job I would leave the teaching profession	( )	( )	( )	( )	( )
I think that the stress and disappointments involved in teaching aren't really worth it	( )	( )	( )	( )	( )

13.) As educators we know the importance of trusting relationships. This section asks you to rate your level of agreement with the following statements concerning interactions and relations with your school's staff members.

	I Do Not Agree	I Agree Slightly	I Agree Somewhat	I Agree Quite a Bit	I Completely Agree
Teachers in this school trust one another	( )	( )	( )	( )	( )
It's OK in this school to discuss feelings, worries, and frustrations with other teachers	( )	( )	( )	( )	( )
Teachers respect other teachers who take the lead in school improvement efforts	( )	( )	( )	( )	( )
Teachers at this school respect those colleagues who are expert at their craft	( )	( )	( )	( )	( )
Teachers in this school feel as though they are in competition with fellow teachers	( )	( )	( )	( )	( )
Teachers in this school typically look out for each other	( )	( )	( )	( )	( )

14.) Please mark the extent to which you agree with the following:

The Principal at this school:

	I Do Not Agree	I Agree Slightly	I Agree Somewhat	I Agree Quite a Bit	I Completely Agree
Makes clear to staff his or her expectations for meeting instructional goals	( )	( )	( )	( )	( )
Communicates a clear vision for our school	( )	( )	( )	( )	( )
Sets high standards for teaching	( )	( )	( )	( )	( )
Understands how children learn	( )	( )	( )	( )	( )
Sets high standards for student learning	( )	( )	( )	( )	( )
Presses teachers to implement what they have learned in professional development	( )	( )	( )	( )	( )
Carefully tracks academic progress	( )	( )	( )	( )	( )
Actively monitors the quality of teaching in this school	( )	( )	( )	( )	( )
Knows what's going on in my classroom	( )	( )	( )	( )	( )

15.) Are you:

( ) Male
( ) Female

16.) Are you:

( ) African-American
( ) Asian-American
( ) Hispanic
( ) White, non-Hispanic
( ) Native American
( ) Biracial/Multiethnic
( ) Other

17.) Please select the primary grade for which you are assigned:

( ) Kindergarten
( ) Grade 1
( ) Grade 2
( ) Grade 3
( ) Grade 4
( ) Grade 5
( ) Grade 6
( ) Grade 7
( ) Grade 8
( ) Grade 9
( ) Grade 10
( ) Grade 11
( ) Grade 12
( ) Other/Multiple

18.) Please select the subject you primarily teach:

( ) Math

( ) Reading/Language Arts/English

( ) Science

( ) Social Studies

( ) Elementary Teacher-Multiple Subjects

( ) Special Ed

( ) Other

19.) What is the highest level of formal education you have completed

( ) Bachelor's degree

( ) Master's degree

( ) Master's degree plus 15 credits or doctorate

20.) How many years have you:

	None	Less Than 1 Year	1 to 3 Years	4 to 5 Years	6 to 10 Years	11 to 15 Years	More than 15 Years
Been a teacher (total)	( )	( )	( )	( )	( )	( )	( )
Taught at this school	( )	( )	( )	( )	( )	( )	( )
Taught in a different school in this district	( )	( )	( )	( )	( )	( )	( )
Taught at a catholic or private school	( )	( )	( )	( )	( )	( )	( )
Worked full time in a profession other than teaching	( )	( )	( )	( )	( )	( )	( )

B.2 PRINCIPAL SURVEY

1.) How many teachers in this school:

	None	A Few	About Half	Most	Nearly All
Help maintain discipline in the entire school, not just their classrooms	( )	( )	( )	( )	( )
Take responsibility for improving the school	( )	( )	( )	( )	( )
Are really trying to improve their teaching	( )	( )	( )	( )	( )
Can you count on to do what they say they will do	( )	( )	( )	( )	( )
Are willing to spend extra time to make the school better	( )	( )	( )	( )	( )

2.) About how many teachers in your school do the following effectively:

	None	A Few	About Half	Most	Nearly All
Implement good instructional practices	( )	( )	( )	( )	( )
Manage student behavior within their classrooms	( )	( )	( )	( )	( )
Demonstrate knowledge of subject matter	( )	( )	( )	( )	( )
Communicate with parents	( )	( )	( )	( )	( )
Evaluate student learning	( )	( )	( )	( )	( )
Collaborate with other teachers around instruction	( )	( )	( )	( )	( )
Develop rapport with students	( )	( )	( )	( )	( )

School Networks

Informal and professional relationships exist in organizations of all types. The following set of questions will ask you to reflect on various relations formed within and outside of your school. These questions will provide you with a list of teachers and other staff members. A few of these people you may interact with quite frequently, while others you may not interact with at all. In the following sets of questions we are interested in understanding with whom you interact and the frequency or strength of those interactions. Please note that your name will appear on the list below. You can simply skip the row that contains your name.

3.) Please indicate the principals in the district below with whom <u>you go to</u> for advice and to discuss professional matters such as school and teacher management, curriculum, community outreach, or organizational change.

	Never	A Few Times A Year	Monthly	Weekly	Daily
Principal 1	( )	( )	( )	( )	( )
Principal 2	( )	( )	( )	( )	( )
Principal 3	( )	( )	( )	( )	( )
Principal 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Principal n	( )	( )	( )	( )	( )

4.) The previous question looked at relations among principals in other schools. The following questions deal with interactions within your own school. Please indicate the members of your school below with whom you are friends. These are people with whom you like to spend your free time, people with whom you plan to go to dinner, visit each other's home, attend concerts or other social events. For individuals you consider to be friends in this regard, please indicate the level of friendship. For all other individuals simply check the box indicating that you are "Just Coworkers". So, if you feel you have one friend within your school environment then choose the level of friendship for that person and for all other individuals check the box for "Just Coworkers".

	Just Coworkers	Slight Friends	Fairly Good Friends	Close Friends	Especially Close Friends
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

5.) The previous question concerned whom you are friends with in the school. This question is directed at information and knowledge exchange. Please indicate on the list below which co-workers <u>you seek out or go to</u> for advice or information. Work related advice or information may concern issues of school and teacher management, curriculum, community outreach, or organizational change. For those that <u>you seek out or go to</u> for advice please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

6.) The previous question asked about coworkers you sought out for advice. This question now asks which coworkers <u>come to you</u> for information or advice on ways to improve their work. With regards to individuals <u>who come to you</u> for advice, please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

7.) Which of the following teachers do you consider to be informal leaders in the school? An informal leader may be someone other teachers look up to and, while not holding an official position of power, have the capacity to influence or lead others. Please select all that apply.

	Is an Informal Leader
Teacher 1	[ ]
Teacher 2	[ ]
Teacher 3	[ ]
Teacher 4	[ ]
.	[ ]
.	[ ]
.	[ ]
Teacher n	[ ]

8.) Below are several factors which could be considered "roadblocks" that prevent a school from improving. Please indicate the extent to which each may be a factor in preventing your school from improving:

	Not a Factor	Somewhat a Factor	Serious Factor
Lack of support from external organizations (e.g., universities, businesses, reform groups, educational consultants, etc.)	( )	( )	( )
Pressure to constantly adopt new programs	( )	( )	( )
Pressure to get test scores up quickly	( )	( )	( )
Pressure to obtain external funds	( )	( )	( )
Disagreements or lack of coordination among school partners	( )	( )	( )
Lack of teacher knowledge and skills	( )	( )	( )
Faculty apathy and resistance to change	( )	( )	( )
Teacher turnover	( )	( )	( )
Difficulty recruiting and hiring the right teachers	( )	( )	( )
Difficulty removing poor teachers	( )	( )	( )
Lack of time to evaluate teachers	( )	( )	( )
State or federal mandates (NCLB, desegregation, special education, bilingual education, etc.)	( )	( )	( )
Mistrust between teachers and parents	( )	( )	( )
Parents apathetic or irresponsible about their children	( )	( )	( )
Problem students (apathetic, hostile, etc.)	( )	( )	( )
Lack of support from the school's community	( )	( )	( )
Social problems in the school's community (poverty, gangs, drugs, etc.)	( )	( )	( )
Racial or ethnic tensions in the school's community	( )	( )	( )
Negative stereotypes about this school's community	( )	( )	( )

General Info

9.) Please mark the extent to which you agree with the following

	Not at All	A Little	Some Degree	Quite a Bit	A Great Deal
I am looking forward to being a principal next year	( )	( )	( )	( )	( )
I am looking forward to being the principal of this school next year	( )	( )	( )	( )	( )
Being a principal this year has been a good experience for me	( )	( )	( )	( )	( )
I feel strongly supported in my school this year	( )	( )	( )	( )	( )

10.) Please estimate what percentage of your time you spend in a given week on the following work related activities.

_____Instructional leadership (For example, curriculum, teacher hiring, evaluation or removal, teacher professional development)

_____Internal school management (For example, budget, SIP, student discipline, attendance, walking hallways, playground or lunchroom)

_____External school management (For example, community, working with parents)

11.) Are you:

( ) Male

( ) Female

12.) Are you:

( ) African-American

( ) Asian-American

( ) Hispanic

( ) White, non-Hispanic

( ) Native American

( ) Biracial/Multiethnic

( ) Other

13.) What is the highest level of formal education you have completed

( ) Bachelor's degree

( ) Master's degree

( ) Master's degree plus 15 credits or doctorate

14.) How many years have you:

	None	Less Than 1 Year	1 to 3 Years	4 to 5 Years	6 to 10 Years	11 to 15 Years	More than 15 Years
Been a principal (total)	( )	( )	( )	( )	( )	( )	( )
Been a principal at this school	( )	( )	( )	( )	( )	( )	( )
Been a principal in a different school in this district	( )	( )	( )	( )	( )	( )	( )
Been a principal in another school district	( )	( )	( )	( )	( )	( )	( )
Worked full time in a profession other than being a principal	( )	( )	( )	( )	( )	( )	( )

B.3 STAFF SURVEY

1.) How many teachers in this school:

	None	A Few	About Half	Most	Nearly All
Help maintain discipline in the entire school, not just their classrooms	( )	( )	( )	( )	( )
Take responsibility for improving the school	( )	( )	( )	( )	( )
Are really trying to improve their teaching	( )	( )	( )	( )	( )
Can you count on to do what they say they will do	( )	( )	( )	( )	( )
Are willing to spend extra time to make the school better	( )	( )	( )	( )	( )

2.) About how many teachers in your school do the following effectively:

	None	A Few	About Half	Most	Nearly All
Implement good instructional practices	( )	( )	( )	( )	( )
Manage student behavior within their classrooms	( )	( )	( )	( )	( )
Demonstrate knowledge of subject matter	( )	( )	( )	( )	( )
Communicate with parents	( )	( )	( )	( )	( )
Evaluate student learning	( )	( )	( )	( )	( )
Collaborate with other teachers around instruction	( )	( )	( )	( )	( )
Develop rapport with students	( )	( )	( )	( )	( )

School Networks

Informal and professional relationships exist in organizations of all types. The following set of questions will ask you to reflect on various relations formed within your school. These questions will provide you with a list of teachers and other staff members. A few of these people you may interact with quite frequently, while others you may not interact with at all. In the following sets of questions we are interested in understanding with whom you interact and the frequency or strength of those interactions. Please note that your name will appear on the list below. You can simply skip the row that contains your name.

3.) Please indicate the members of the school below with whom you are friends. These are people with whom you like to spend your free time, people with whom you plan to go to dinner, visit each other's home, attend concerts or other social events. For individuals you consider to be friends in this regard, please indicate the level of friendship. For all other individuals simply check the box indicating that you are "Just Coworkers". So, if you feel you have one friend within your school environment then choose the level of friendship for that person and for all other individuals check the box for "Just Coworkers".

	Just Coworkers	Slight Friends	Fairly Good Friends	Close Friends	Especially Close Friends
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

4.) The previous question concerned whom you are friends with in the school. This question is directed at information and knowledge exchange. Please indicate on the list below which co-workers <u>you seek out or approach</u> for advice about your work. Depending on your position, work related advice may concern information on ways to strengthen practice, ideas on teaching style, lesson planning, classroom management, or for other work related reasons. For those that <u>you seek out</u> for advice please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

5.) The previous question asked about coworkers you sought out for advice. This question now asks which coworkers <u>come to you</u> for advice. With regards to individuals <u>who come to you</u> for advice, please indicate the frequency of interaction.

	Never	A Few Times a Year	Monthly	Weekly	Daily
Coworker 1	( )	( )	( )	( )	( )
Coworker 2	( )	( )	( )	( )	( )
Coworker 3	( )	( )	( )	( )	( )
Coworker 4	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
.	( )	( )	( )	( )	( )
Coworker n	( )	( )	( )	( )	( )

6.) Which of the following teachers do you consider to be informal leaders in the school? An informal leader may be someone other teachers look up to and, while not holding an official position of power, have the capacity to influence or lead others. Please select all that apply.

	Is an Informal Leader
Teacher 1	[ ]
Teacher 2	[ ]
Teacher 3	[ ]
Teacher 4	[ ]
.	[ ]
.	[ ]
.	[ ]
Teacher n	[ ]

7.) Below are several factors which could be considered "roadblocks" that prevent a school from improving. Please indicate the extent to which each may be a factor in preventing your school from improving:

	Not a Factor	Somewhat a Factor	Serious Factor
Lack of support from external organizations (e.g., universities, businesses, reform groups, educational consultants, etc.)	( )	( )	( )
Pressure to constantly adopt new programs	( )	( )	( )
Pressure to get test scores up quickly	( )	( )	( )
Pressure to obtain external funds	( )	( )	( )
Disagreements or lack of coordination among school partners	( )	( )	( )
Lack of teacher knowledge and skills	( )	( )	( )
Faculty apathy and resistance to change	( )	( )	( )
Teacher turnover	( )	( )	( )
Difficulty recruiting and hiring the right teachers	( )	( )	( )
Difficulty removing poor teachers	( )	( )	( )
Lack of time to evaluate teachers	( )	( )	( )
State or federal mandates (NCLB, desegregation, special education, bilingual education, etc.)	( )	( )	( )
Mistrust between teachers and parents	( )	( )	( )
Parents apathetic or irresponsible about their children	( )	( )	( )
Problem students (apathetic, hostile, etc.)	( )	( )	( )
Lack of support from the school's community	( )	( )	( )
Social problems in the school's community (poverty, gangs, drugs, etc.)	( )	( )	( )
Racial or ethnic tensions in the school's community	( )	( )	( )
Negative stereotypes about this school's community	( )	( )	( )

8.) Are you:

( ) Male

( ) Female

9.) Are you:

( ) African-American

( ) Asian-American

( ) Hispanic

( ) White, non-Hispanic

( ) Native American

( ) Biracial/Multiethnic

( ) Other

10.) What is the highest level of formal education you have completed

( ) Bachelor's degree

( ) Master's degree

( ) Master's degree plus 15 credits or doctorate

11.) How many years have you:

	None	Less Than 1 Year	1 to 3 Years	4 to 5 Years	6 to 10 Years	11 to 15 Years	More than 15 Years
Been at your current position (curriculum coach, asst. principal, counselor, etc...) in any school or district (total)	( )	( )	( )	( )	( )	( )	( )
Been at your position at this school	( )	( )	( )	( )	( )	( )	( )
Been at your position in a different school in this district	( )	( )	( )	( )	( )	( )	( )
Been at your position in another school district	( )	( )	( )	( )	( )	( )	( )
Worked full time in a profession other than your current position	( )	( )	( )	( )	( )	( )	( )

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