Ties with potential: nature, antecedents, and consequences of social networks in school teams

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CHAPTER 2

The Social Forces in Elementary School Teams:
How Demographic Variables Shape Social Networks

ABSTRACT

Background. Research on social networks in schools is increasing rapidly. Network studies outside education have indicated that the structure of social networks is partly affected by demographic characteristics of network members. Yet, knowledge on how teacher social networks are shaped by teacher and school demographics is scarce.

Purpose. The goal of this study was to examine the extent to which teachers’ work related social networks are affected by teacher and school demographic characteristics.

Method. Survey data were collected among 316 educators from 13 elementary schools in a large educational system in the Netherlands. Using social network analysis, in particular multilevel p2 modeling, we analyzed the effect of teacher and school demographics on individual teachers’ probability of having relationships in a work discussion network.

Conclusions. Findings indicate that differences in having relationships were associated with differences in gender, grade level, working hours, formal position, and experience. We also found that educators tend to prefer relationships with educators with the same gender and from the same grade level. Moreover, years of shared experience as a school team appeared to affect the likelihood of teacher relationships around work related discussion.

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53
INTRODUCTION

Relationships among educators are more and more regarded as an important element to schools’ functioning, and a potential source of school improvement. Educational practitioners and scholars around the world are targeting teacher interaction as a way to facilitate knowledge exchange and shared teacher practice through a variety of collaborative initiatives, such as communities of practice, professional learning communities, and social networks (Daly & Finnigan, 2009; Hord, 1997; Lieberman & McLaughlin, 1992; Wenger, 1998). The growing literature base around these concepts suggests that ‘relationships matter’ for fostering a climate of trust and a ‘safe and open’ environment to implement reform and engage in innovative teacher practices (Bryk & Schneider, 2002; Louis, Marks, & Kruse, 1996; Coburn & Russell, 2008; Penuel, Fishman, Yamaguchi, & Galagher, 2007a).

Social network literature asserts that relationships matter because the configuration of social relationships offers opportunities and constraints for collective action (Burt, 1983a, Coleman, 1990; Granovetter, 1973; Lochner, Kawachi, & Kennedy, 1999). For instance, the extent to which an organizational network supports the rate and ease with which knowledge and information flows through the organization may provide it with an advantage over its competitors (Nahapet & Ghoshal, 1998; Tsai, 2001). While social network studies have mainly concentrated on the consequences of social networks for individuals and groups, less attention has been paid to how social networks are conditioned upon individual characteristics and behavior (Borgatti & Foster, 2003). A developing set of studies in organizational literature is focusing on how attributes of individuals such as personality traits affect their social network (e.g., Burt, Jannotta & Mahoney, 1998; Mehra, Kilduff, & Brass, 2001; Madhavan, Caner, Prescott, & Koka, 2008), how individuals select others to engage in relationships (Kossinets & Watts, 2006; McPherson, Smith-Lovin, & Cook, 2001), and how organizations enter into alliances with other organizations (Gulati & Gargiulo, 1999). These studies offer valuable insights in potential individual and organizational attributes that may affect the pattern of social relationships in school teams.

Attributes that are especially worth investigating for their potential to shape the social structure of school teams are demographic characteristics (cf. Ely, 1995; Tsui, Egan, & O’Reilly, 1992). Demographic characteristics are more or less constant elements that typify teachers, their relationships, and schools based on socio-economic factors such as age, gender, teaching experience, and school team composition. Several network studies have suggested that
networks are at least in part shaped by demographic characteristics of individuals, their dyadic relationships, and the network (Brass, 1984; Heyl, 1996; Ibarra 1992, 1995; Lazega & Van Duijn, 1997; Veenstra et al., 2007; Zijlstra, Veenstra, & Van Duijn, 2008). For instance, several studies reported that relationships among individuals with the same gender are more likely than relationships among individuals with opposite gender (a so-called homophily effect) (Baerveldt, Van Duijn, Vermeij, & Van Hemert, 2004; McPherson, Smith-Lovin & Cook, 2001). These studies, however, seldom purposely aim to examine the impact of demographic characteristics on social networks and consequently only include few demographic variables of network members. Insights in the extent to which social relationships are formed in the light of multiple individual and organizational demographic characteristics are limited, and even more so in the context of education. We argue that such groundwork knowledge is crucial for all those who aim to optimize social networks in support of school improvement and, ultimately, student achievement.

This chapter aims to examine the extent to which social networks in school teams are shaped by individual, dyadic, and school level demographic variables, such as teachers’ gender and age, school team composition and team experience, and students’ socio-economic status. We conducted a study among 316 educators in 13 Dutch elementary schools. Results of this study were expected to increase insights in the constant social forces that may partly define teachers’ relationships in their school teams, and discover potential tendencies around, for example, homophily and structural balance. Based on a literature review of social network studies that include demographic variables in a wide range of settings, we pose several hypotheses on the extent to which demographical variables at the individual, dyadic, and school level may affect teachers’ social networks.

THEORETICAL FRAMEWORK

Individual level demographics that may shape teachers’ social networks
Social network literature has suggested various individual demographic characteristics to affect their pattern of relationships, and as such social networks as a whole (Heyl, 1996; Lazega & Van Duijn, 1997; Veenstra et al., 2007; Zijlstra, Veenstra, & Van Duijn, 2008). Following these suggestions, we will first review how individual level demographic characteristics may affect teachers’ social networks. We focus on the individual demographics gender, formal position, working hours, experience at school, age, and grade level for
their potential influence on teachers’ patterns of social relationships and school
teams’ social network structure.

Gender. The likelihood of having relationships in a network may be
associated with gender (Metz & Tharenou, 2001; Moore, 1990; Stoloff et al.,
1999; Veenstra et al., 2007; Zijlstra, Veenstra, & Van Duijn, 2008). Previous
research has indicated that gender affects network formation (Burt et al., 1998;
Hughes, 1946; Ibarra, 1993, 1995, Moore, 1990; Pugliesi, 1998; Van Emmerik,
2006) and that, in general, women tend to have more relationships than men
(Mehra, Kilduff, & Brass, 1998). These differences are already found in
childhood (Frydenberg & Lewis, 1993) and continue to exist through life
(Parker & De Vries, 1993; Van der Pompe & De Heus, 1993). In various settings
and cultures, both men and women were found to use men as network routes
to achieve their goals and acquire information from more distant domains
(Aldrich et al., 1989; Bernard et al., 1988). Following these findings, we
hypothesize that male teachers will have a higher likelihood of receiving more
relationships than female teachers, and women will send more relationships
than men (Hypothesis 1a).

Formal position. Previous research in organizations (Lazega & Van Duijn,
1997; Moore, 1990) and education (Coburn, 2005a; Coburn & Russell, 2008; Daly
& Finnigan, 2009; Heyl, 1996) suggests that the formal position of individuals
may be related to their relational activity and popularity. For instance, Lazega
& Van Duijn (1997) found that lawyers were more often sought out for advice
when they held a higher hierarchical position. Research has indicated that the
network position of an organizational leader is important in terms of access and
leveraging social resources through social relationships as well as brokering
between teachers that are themselves unconnected (Balkundi & Harrison, 2006;
Balkundi & Kilduff, 2005). In line with these studies, we expect that principals
will be more sought out for work related discussions than teachers. We also
expect that principals will report to be involved in more relationships than
teachers, since they depend on these relationships to gather information and
convey knowledge, plans, and expertise to support student learning and
monitor the functioning of teachers and the school. Moreover, principals are
reported to occupy a strategic position in the flow of information between the
district office and teachers and relay important policy and organizational
information from the district office to the teachers (Coburn, 2005a; Coburn &
Russell, 2008). Therefore, we hypothesize that principals have a higher
likelihood of sending and receiving relationships (Hypothesis 1b).

Working hours. In addition, the number of working hours that an educator
spends at the school may also affect his/her opportunity to initiate and
maintain social relationships. Recent research suggests that the relationship between network embeddedness and job performance is related to working hours (Van Emmerik & Sanders, 2004). In line with this finding, it is hypothesized that educators who work full time will have a higher probability of sending and receiving relationships than educators with part time working hours (Hypothesis 1c).

Experience at the school. Another demographic characteristic that may affect an individual’s pattern of relationships is seniority, or experience at the school. The previously mentioned law study (Lazega & Van Duijn, 1997) indicated that senior lawyers had a higher probability of being sought out for advice than junior lawyers. Besides having more work experience, a perceived network advantage of senior lawyers may be that they have built more strong, durable, and reliable relationships over time, and therefore have access to resources that are unattainable for more junior lawyers. Accordingly, we hypothesize that educators who have more experience in their school team have a higher likelihood of sending and receiving work discussion relationships than educators who have less experience in the school team (Hypothesis 1d).

Age. Network research in other contexts found age differences in relation to the amount of relationships that individuals maintain (Cairns, Leung, Buchanan, & Cairns, 1995; Gottlieb & Green, 1984). In general, these studies suggest that the amount of relationships that people maintain tend to decrease with age. However, with increased age, experience at the school also increases together with the amount of relationships based on seniority (Lazega & Van Duijn, 1997). In concordance with the latter, we hypothesize that age will positively affect the probability of work related ties, meaning that older teachers are more likely to send and receive work related relationships than younger teachers (Hypothesis 1e).

Grade Level. Within schools, formal clustering around grade level may affect the pattern of relationships among educators. The grade level may to a certain extent affect the amount of interaction among educators since grade level teams may have additional grade level meetings and professional development initiatives are often targeted at the grade level (Daly et al., in press; McLaughlin & Talbert, 1993; Newmann, King, & Youngs, 2000; Newmann & Wehlage, 1995; Wood, 2007; Stoll & Louis, 2007). Dutch elementary schools are relatively small compared to U.S. elementary schools, and are often divided into a grade level team for the lower grades (K – 2) and a grade level team for the upper grades (3 – 6). The amount of relationships that teachers have, may partly be defined by the requirements of and opportunities provided by their grade level team. We may expect that teachers that teach
upper grade levels send and receive more relationships than teachers that teach lower grade levels because of the increasingly diverse and demanding curriculum in the upper grades combined with intensified student testing and preparation for education after elementary school. These conditions may require more work related discussion of upper grade level teachers than of lower grade level teachers. As such, we expect that teachers that teach upper grade levels have a higher likelihood of sending and receiving relationships than teachers that teach lower grade levels (Hypothesis 1f).

Dyadic level demographics that may shape teachers’ social networks
Dyadic level demographics are demographics that typify the relationship between two individuals. Dyadic level effects give insights in network homophily. Network homophily is arguably the most well-known social network concept that often explicitly focuses on demographic characteristics of network members. The concept of homophily, also known by the adage ‘birds of a feather flock together’, addresses similarity between two individuals in a dyadic (paired) relationship. Homophily literature builds on the notion that individuals are more likely to develop and maintain social relationships with others that are similar to them on specific attributes, such as gender, organizational unit, or educational level (Marsden, 1988; McPherson & Smith-Lovin, 1987; McPherson, Smith-Lovin, & Cook, 2001). Similarly, individuals who differ from each other on a specific attribute are less likely to initiate relationships, and when they do, heterophilous relationships also tend to dissolve at a faster pace than homophilous relationships (McPherson et al., 2001).

Homophily effects result from processes of social selection and social influence. Social selection refers to the idea that individuals tend to choose to interact with individuals that are similar to them in characteristics such as behavior and attitudes. At the same time, individuals that interact with each other influence each others’ behavior and attitudes, which may increase their similarity (McPherson et al., 2001). This is a process of social influence. In addition, individuals who share a relationship also tend to share similar experiences through their relationship (Feld, 1981).

Homophily is related to the concept of structural balance. In the footsteps of cognitive balance theory, structural balance theory poses that individuals will undertake action to avoid or decrease an unbalanced network (Heider, 1958). Over time, people tend to seek balance in their network by initiating new strong relationships with friends of friends and terminate relationships with friends of enemies or enemies of friends (Wasserman & Faust, 1997). As a result
from this tendency towards structural balance, relatively homogenous and
strong cliques may be formed that give the network some stability over time
(Kossinets & Watts, 2006). Structural balance and network homophily may have
also have a negative influence on individuals' social networks as the resulting
network homogeneity and pattern of redundant relationships may limit their
access to valuable information and expertise (Little, 1990; Burt, 1997, 2000). In
this study we focus on two types of similarity that may define teachers’
relationships, namely gender similarity and grade level similarity.

*Gender similarity.* A dyadic attribute that may affect teachers’ patterns of
social relationships is the gender similarity between two teachers. Several
studies have shown that work and voluntary organizations are often highly
gender segregated (Bielby & Baron, 1986, McGuire, 2000; McPherson & Smith-
Lovin, 1986, 1987; Popielarz, 1999; Van Emmerik, 2006). This gender homophily
effect already starts at a young age (Hartup, 1993; Cairns & Cairns, 1994;
Furman & Buhrmester, 1992). In the context of education, Heyl (1996) suggested
an effect of gender homophily on interactional patterns among teachers,
indicating that for men and women relationships with the opposite gender are
less frequent or intense than relationships among men or relationship among
women. In line with this suggestion, we hypothesize a homophily effect for
gender, meaning that educators will prefer same-gender relationships over
relationships with teachers of the opposite gender (*Hypothesis 2a*).

*Grade level similarity.* Another dyadic attribute that may shape the pattern
of teachers’ relationships is the grade level. In the Netherlands, schools are
relatively small compared to the United States, with often only one full time or
two part time teachers per grade level. Commonly, Dutch school teams are
formally divided into two grade level levels representing the lower
(‘onderbouw’, often K-2 or K-3) and upper grades (‘bovenbouw’, often grades
3-6 or 4-6), which are often located in close physical proximity. Recent research
suggests that teachers who are located closely to each another are more likely to
interact with each other than with teachers that are less physically proximate
(Coburn & Russell, 2008). Moreover, most schools have separate breaks for the
lower and upper grades, and some schools hold additional formal meetings for
the lower/upper grades to discuss issues related to these grades. Since shared
experiences are argued to result in greater support among individuals (Feld,
1981; Suitor & Pillemer, 2000; Suitor, Pillemer, & Keeton, 1995), these
organizational features will increase the opportunity for teachers from the same
grade level to interact relative to teachers from a different grade level.
Therefore, we hypothesize a homophily effect for grade level, meaning that
teachers will more likely maintain relationships with teachers from their own
grade level than with teachers that teach the other grade level (e.g., lower or upper level) (Hypothesis 2b).

School level demographics that may shape teachers’ social networks
Although teachers can often choose with whom they interact, the social structure of their school’s network is partly outside their span of control (Burt, 1983a; Brass & Burkhardt, 1993; Gulati, 1995b). Just as individual relationships may constrain or support a teacher’s access to and use of resources (Degenne & Forsé, 1999), the social structure surrounding the teacher may influence the extent to which teachers may shape their network so as to expect the greatest ‘return on investment’ (Burt, 1992; Flap & De Graaf, 1989; Ibarra, 1992, 1993, 1995; Lin & Dumin, 1986; Little, 1990). Because of the embeddedness and interdependency of individuals in their social network, relationships and attributes at a higher level will affect lower-level relationships (Burt, 2000). As such, demographic characteristics at the school level may affect teachers’ patterns of relationships. We pose that the following school level demographic characteristics affect teachers’ pattern of social relationships: gender ratio, average age, school team experience, school size, school team size, and socio-economic status of the schools’ students.

Gender ratio and average age. Above and beyond the influence of individual demographics on the tendency to form relationships, there may be aggregates of these individual demographics at the level of the school team that may affect teachers’ tendency to form and maintain relationships. Research in a law firm demonstrated that above the influence of individual level seniority, a lawyer’s position in the firm’s network was in part dependent on the ratio of juniors to seniors in the team (Lazega & Van Duijn, 1997). For school teams, a compositional characteristic that may affect patterns of relationships is gender ratio, or the ratio of the number of female to male teachers. In a school team with a high ratio of female teachers (which is not unusual in Dutch elementary education) male teachers have fewer options for homophily friendships with same-sex peers than women. Therefore, male teachers in such a team may have a lower tendency to maintain relationships in general and a higher propensity towards relationships with women than men in school teams with relatively more male teachers. Research confirms that the gender composition of a team may significantly affect gender homophily, with the minority gender often having much more heterophilous networks than the majority (McPherson, Smith-Lovin, & Cook, 2001). Therefore, we expect that the gender ratio of the school team will shape teachers’ social networks. In line with previous empirical work suggesting that women tend to have more relationships than
men (Mehra, Kilduff, & Brass, 1998), we expect that teachers in school teams with a high female ratio will have a higher likelihood of sending and receiving ties than individuals in teams with relatively more male teachers (Hypothesis 3a). Along the same lines, if we expect that age will increase the likelihood of sending and receiving relationships, then increased average age of a school team may also enhance the probability of relationships. Therefore, we hypothesize that average age is positively related to the probability of ties (Hypothesis 3b).

**Team experience, school size, and team size.** Prior research has indicated that individuals are more likely to reach out to others with whom they had previous relationships (Coburn & Russell, 2008). Given the time and shared experiences that are necessary for building relationships, we may assume that the number of years that a school team has been functioning in its current configuration, without members leaving or joining the team, may affect teachers’ likelihood of maintaining relationships. Therefore we include school team experience as a school level demographic that may positively affect teachers’ patterns of relationships (Hypothesis 3c). Other school demographics that may affect teachers’ inclinations to form relationships are school size (number of students) and team size (number of educators). Previous literature has suggested that the size of organizations and networks is directly related to the pattern of social relationships in organizations (Tsai, 2001). In general, the amount of individual relationships and the density of social networks decrease when network size increases. As such, we may expect a lower probability of relationships in schools that serve more students (Hypothesis 3d) and schools with larger school teams (Hypothesis 3e).

**Students’ socio-economic status.** Social networks can be shaped by both endogenous and exogenous forces (Gulati, Nohria, & Zaheer, 2000). An exogenous force to the school team that has been demonstrated to affect schools’ functioning is the socio-economic status (SES) of its students (Sirin, 2005; White, 1982). We argue that the socio-economic status of the children attending the school may influence the probability that teachers will form relationships. For instance, teachers’ perceptions of the urgency for communication and innovation may be dependent on the community surrounding the school. Typically, schools that serve more high-needs communities are associated with greater urgency in developing new approaches (Sunderman, Kim & Orfield, 2005), which may relate to an increased probability of relationships among educators. Therefore, we hypothesize that teachers in low SES schools will have a higher probability of having relationships than teachers in high SES schools (Hypothesis 3f).
Table 1. Sample demographics of schools and educators (N = 13, n = 316)

<table>
<thead>
<tr>
<th>Individual level</th>
<th>Male</th>
<th>Female</th>
<th>Gender</th>
<th>95 (30.1 %)</th>
<th>221 (69.9 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working hours</td>
<td>Part time (less than 32 hours)</td>
<td>143 (45.2 %)</td>
<td>Full time (32 hours or more)</td>
<td>173 (54.8 %)</td>
<td></td>
</tr>
<tr>
<td>Experience at school</td>
<td>1-3 years</td>
<td>42 (13.3 %)</td>
<td>4-10 years</td>
<td>110 (34.9 %)</td>
<td>&gt; 10 years</td>
</tr>
<tr>
<td>Grade level¹</td>
<td>Lower grade (K - 2)</td>
<td>156 (49.4 %)</td>
<td>Upper grade (3-6)</td>
<td>160 (50.6 %)</td>
<td></td>
</tr>
</tbody>
</table>

| School level              | 6 months to 2 years | 5 (38.5 %) | More than 2 years | 8 (61.5 %) |

Table 2. Sample demographics of schools and educators (N = 13, n = 316)

<table>
<thead>
<tr>
<th>Individual level</th>
<th>N</th>
<th>M</th>
<th>Sd</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>316</td>
<td>46.5</td>
<td>9.9</td>
<td>21</td>
<td>62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>School level</th>
<th>N</th>
<th>M</th>
<th>Sd</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender ratio²</td>
<td>13</td>
<td>72.4</td>
<td>8.4</td>
<td>59.1</td>
<td>87.0</td>
</tr>
<tr>
<td>Average age</td>
<td>13</td>
<td>46.4</td>
<td>2.5</td>
<td>41.1</td>
<td>50.6</td>
</tr>
<tr>
<td>Number of students</td>
<td>13</td>
<td>371</td>
<td>79.3</td>
<td>287</td>
<td>545</td>
</tr>
<tr>
<td>Team size</td>
<td>13</td>
<td>26.0</td>
<td>4.0</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>Socio-economic status (SES)³</td>
<td>13</td>
<td>9.2</td>
<td>9.3</td>
<td>0.5</td>
<td>30.5</td>
</tr>
</tbody>
</table>

¹ Educators who can be considered to be a part of both lower and upper grade were asked to choose with which grade level they worked most (e.g., principal, specialist staff).
² Gender ratio is calculated as the percentage of female team members.
³ SES is calculated as the weighted percentage of students for whom the school receives extra financial resources.
METHOD

Context
The study took place at 13 elementary schools in south of The Netherlands. The schools were part of the Avvansa School District\(^1\) that provided IT, financial, and administrative support to 53 schools in the south of The Netherlands. At the time of the study, the district had just initiated a program for teacher development that involved a benchmark survey for the monitoring of school improvement. We selected a subsample of all the district schools based on a team size of 20 or more team members, since trial runs of the p2 estimation models encountered difficulties converging with smaller network sizes and more schools. The original sample consisted of 53 schools that, with the exception of school team and number of students, did not differ considerably from the 13 sample schools with regard to the described demographics.

The context of Dutch elementary schools was beneficial to the study in three ways. First, the school teams were relatively small, which facilitated the collection of whole network data. Second, school teams are social networks with clear boundaries, meaning the distinction of “who is part of the team” is unambiguous for both researchers and respondents. Third, in contrast to many organizations, school organizations are characterized by relatively flat organizational structures, in which educators perform similar tasks and job diversification is relatively small. Often, educators have had similar training backgrounds, and are receiving school wide professional development as a team. Therefore, despite natural differences in individual characteristics, teachers in Dutch elementary school teams are arguably more comparable among each other than organizational employees in many other organizations, making demographic characteristics possibly less related to differences in tasks or task-related status differences.

Sample
The sample schools served a student population ranging from 287 to 545 students in the age of 4 to 13. We collected social network data from 13 principals and 303 teachers, reflecting a response rate of 94.5 %. Of the sample, 69.9 % was female and 54.8 % worked full time (32 hours or more). Educators’ age ranged from 21 to 62 years (M = 46.5, sd = 9.9 years). Additional demographic information is depicted in Table 1 and 2.

\(^1\) All names are pseudonyms
Chapter 2

Instruments

Social networks. We assessed the influence of demographic variables on a network that was aimed at capturing work related communication among educators. The network of discussing work related matters was selected because it is assumed to be an important network for the exchange of work related information, knowledge, and expertise that may affect individual and group performance (Sparrowe, Liden, Wayne, & Kraimer, 2001). Moreover, according to the previous analysis into network multiplexity (see Chapter 1), this network appeared to be an instrumental network with relatively small overlap with expressive networks. We asked respondents the following question: ‘Whom do you turn to in order to discuss your work?’ A school-specific appendix was attached to the questionnaire comprising the names of the school team members, accompanied by a letter combination for each school team member (e.g., Ms. Yolanda Brown\(^1\) = AB). The question could be answered by indicating a letter combination for each colleague who the respondent considered part of his/her work discussion network. The number of colleagues a respondent could indicate as part of his/her network was unlimited.

Individual, dyadic, and school level attributes. We collected demographic variables to assess how individual, dyadic, and school level attributes shape the pattern of social relationships among educators. At the individual level, we examined the following individual attributes: gender, formal position (teacher/principal), working hours (part time/full time), number of years experience at school, age, and whether a teacher was teaching in lower grade or upper grade. At the dyadic level, we included similarity of gender and similarity of grade level (lower/upper grade). At the school level, we investigated school size, team size, gender ratio, average age, years of team experience in current formation, and students’ socio-economic status (SES).

Data analysis

Analysis strategy

Since our dependent variable consisted of social network data that are by nature interdependent (relationships among individuals), the assumption of data independence that underlies conventional regression models is violated. Therefore, we employed multilevel p2 models to investigate the effect of individual, dyadic, and school level demographics on having work-related

\(^1\) All names are pseudonyms
relationships (Van Duijn et al., 2004; Baerveldt et al., 2004; Zijlstra, 2008). The p2 model is similar to a logistic regression model, but is developed to handle dichotomous dyadic outcomes. In contrast to a univariate logistic regression model, the p2 model controls for the interdependency that resides in social network data. The model focuses on the individual as the unit of analysis. The p2 model regards sender and receiver effects as latent (i.e., unobserved) random variables that can be explained by sender and receiver characteristics (Veenstra, et al., 2007). In the multilevel p2 analyses, the dependent variable is the aggregate of all the nominations a team member sent to or received from others. A positive effect thus indicates that the independent demographic variable has a positive effect on the probability of a relationship. We used the p2 program within the StOCNET software suite to run the p2 models (Lazega & Van Duijn, 1997; Van Duijn, Snijders, & Zijlstra, 2004). This software has been recently modified to fit multilevel data (Zijlstra, 2008; Zijlstra, Van Duijn, & Snijders, 2006). We make use of this recent development by calculating multilevel p2 models for our data.

The social network data in this study have a three-level structure. Network data were collected from 13 schools (Level 3) with 316 educators (Level 2) and 11,241 dyadic relationships (Level 1). To examine the influence of individual, dyadic, and school level demographics on the likelihood of having work related relationships we constructed two multilevel models. In the first multilevel model, the effects of individual and dyadic level demographics on the possibility of having relationships were examined. In the second multilevel model, school level demographic variables were added to the model in order to explain the additional effect of school level demographics on the possibility of having relationships, above and beyond the effects of individual and dyadic level demographics. For the multilevel p2 models, we used a subsample of the 13 schools with a team size of 20 educators or more. We selected this subsample of 13 schools from a larger sample of 53 schools to reduce computing time and to examine schools that were more comparable in network size. Still, each model estimation took about six hours of computing time.

How to interpret p2 estimates
In general, effects in p2 models can be interpreted in the following manner. Results on the variables of interest include both sender effects and receiver effects, meaning effects that signify the probability of sending or receiving a relationship nomination. A positively significant parameter estimate can be interpreted as the demographic variable having a positive effect on the probability of a relationship (Veenstra et al., 2007). For instance, a positive sender effect of
formal position with dummy coding (teacher/principal) means that the position with the upper dummy code (principal) will have a higher probability of sending relationships than the position with the lower dummy code (teacher).

To assess homophily effects, dyadic matrices were constructed based on the absolute difference between two respondents. For example, the dyadic relationship between male and female educators would be coded as a relationship between educators with a different gender because the absolute difference between male (dummy variable = 0) and female (dummy code = 1) is 1. Smaller numbers thus represent greater interpersonal similarity in gender. The same procedure was carried out for grade level differences. To facilitate the interpretation of the models, we labeled the dyadic parameters ‘different gender’ and ‘different grade level’. A negative parameter estimate for ‘different gender’ would thus indicate that a difference in gender is related to a lower probability of having relationships. Meaning, teachers with different gender are less likely to report a relationship, and conversely, relationships are more likely among same-gender teachers. As such, negative parameters would provide evidence of the hypothesized homophily effects.

In p2 models, two parameters are by default included as they ‘control’ for important network effects. The first default parameter is the overall mean density effect. A positive density effect indicates that overall, the networks are rather dense, whereas a negative density effect indicates that the networks are rather sparse. Technically phrased, when the density parameter is negative, the probability of a tie is lower than 0.50. The second default parameter is the overall mean reciprocity effect. A positive reciprocity effect means that symmetric relationships are more likely to occur than asymmetric relationships, while a negative reciprocity effect signifies a higher probability of asymmetric relationships in the networks. In addition, the p2 models include information on differences in nominating (sender variance), in receiving nominations (receiver variance), and the extent to which people who send more relationships also have a higher probability of receiving relationships (sender-receiver covariance).

RESULTS

The effect of individual and dyadic level demographics on work discussion relationships
The results for the p2 analyses are reported in Table 3. We will first examine model 1, in which we include individual and dyadic demographic variables in the prediction of having a work-related relationship. To recall, our first
hypothesis was that 1a) men will receive more relationships than women, and women will send more relationships than men. Subsequent hypotheses posed that the probability of being involved in relationships was higher for 1b) principals, 1c) full time employed educators, 1d) educators who had more experience working at the school, 1e) older educators, and 1f) upper grade level teachers. Moreover, we hypothesized that homophily effects would be found for 2a) gender and 2b) grade level. The results for the multilevel p2 models are presented in Table 3.

Findings indicate a negative density effect, suggesting that the work related networks are overall rather sparse. The positive reciprocity effect signifies that on average, work related relationships have a higher probability to be reciprocated than to be unidirectional. There is considerable variation among educators in the amount of ties that they send, as signified by the sender variance effect. There is less variation among educators in the amount of relationships that they receive, as represented by the receiver variance. The model with only individual and relationship covariates has a positive sender-receiver covariance, indicating that, in general, individuals who send more ties also receive more ties. When we take school level differences in demographics into account, results signify a negative sender-receiver covariance. Meaning, when taking differences between schools into account, educators who report to send more ties have a lower probability of receiving ties.

In regard to the sender covariates, results indicate that none of the individual characteristics increased the probability of sending ties. In other words, women did not send more relationships than men, and being a principal, working full time, having more experience at the school, or being older did not affect the number of relationships that an educator sends out with regard to work related discussions. An examination of the receiver covariates rendered a positive effect for formal position and teacher experience at school, indicating that a higher score on formal position and teacher experience at school had a higher probability of sending ties than a lower score. This means that principals and those who have worked at the school for a longer time had a higher probability to be sought out for a work related discussion. As such, Hypotheses 1b and 1d could be partially supported.

Results on the effect of dyadic covariates confirmed the existence of homophily effects for gender and grade level. In general, educators tended to prefer relationships with same-gender peers and peers from their own grade-level. Thus, educators from upper grades were more likely to have relationships with colleagues that taught in upper grade as well, and the same holds among lower grade educators. These findings confirm hypotheses 2a and 2b.
Table 3. *Whom do you turn to in order to discuss your work?* The effect of sender and receiver demo-graphic variables on the probability of having a work related relationship. Parameter estimates of the multilevel $p_2$ models ($n = 316$).

<table>
<thead>
<tr>
<th>Overall mean</th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Posterior mean</td>
<td>SE</td>
<td>95% CI</td>
<td>Posterior mean</td>
</tr>
<tr>
<td>Density</td>
<td>-3.03</td>
<td>1.45</td>
<td>(-0.87/0.47)</td>
<td>0.35</td>
</tr>
<tr>
<td>Reciprocity</td>
<td>2.27</td>
<td>0.19</td>
<td>10.68</td>
<td>10.98</td>
</tr>
</tbody>
</table>

**Sender covariates**

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Posterior mean</td>
<td>SE</td>
<td>95% CI</td>
<td>Posterior mean</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>-0.09</td>
<td>0.32</td>
<td>(-0.87/0.47)</td>
<td>3.86***</td>
</tr>
<tr>
<td>Formal position</td>
<td>0.20</td>
<td>0.29</td>
<td>(-0.34/0.90)</td>
<td>0.16</td>
</tr>
<tr>
<td>Working hours</td>
<td>-0.35</td>
<td>0.30</td>
<td>(-0.84/0.21)</td>
<td>-0.73</td>
</tr>
<tr>
<td>Experience at school</td>
<td>0.04</td>
<td>0.10</td>
<td>(-0.16/0.27)</td>
<td>0.13</td>
</tr>
<tr>
<td>Age</td>
<td>-0.03</td>
<td>0.01</td>
<td>(-0.05/0.00)</td>
<td>0.09</td>
</tr>
<tr>
<td>Grade level</td>
<td>0.21</td>
<td>0.37</td>
<td>(-0.52/0.81)</td>
<td>5.04**</td>
</tr>
</tbody>
</table>

**Receiver level covariates**

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Posterior mean</td>
<td>SE</td>
<td>95% CI</td>
<td>Posterior mean</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>0.28</td>
<td>0.22</td>
<td>(-0.08/0.68)</td>
<td>-4.02***</td>
</tr>
<tr>
<td>Formal position</td>
<td>1.04***</td>
<td>0.26</td>
<td>(0.51/1.54)</td>
<td>0.96</td>
</tr>
<tr>
<td>Working hours</td>
<td>0.00</td>
<td>0.22</td>
<td>(-0.49/0.39)</td>
<td>-5.25***</td>
</tr>
<tr>
<td>Experience at school</td>
<td>0.29***</td>
<td>0.05</td>
<td>(0.20/0.40)</td>
<td>-0.79**</td>
</tr>
<tr>
<td>Age</td>
<td>-0.02</td>
<td>0.01</td>
<td>(-0.04/0.00)</td>
<td>-0.12***</td>
</tr>
<tr>
<td>Grade level</td>
<td>0.13</td>
<td>0.19</td>
<td>(-0.19/0.57)</td>
<td>-1.62</td>
</tr>
</tbody>
</table>
### Relationship covariates

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Estimate</th>
<th>SE</th>
<th>CI Lower</th>
<th>CI Upper</th>
<th>Z</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different gender</td>
<td>-0.82***</td>
<td>0.14</td>
<td>(-1.09/-0.53)</td>
<td>-0.51***</td>
<td>0.14</td>
<td>(-0.83/-0.25)</td>
</tr>
<tr>
<td>Different grade level</td>
<td>-0.70***</td>
<td>0.13</td>
<td>(-0.99/-0.48)</td>
<td>-0.43*</td>
<td>0.21</td>
<td>(-0.94/-0.09)</td>
</tr>
</tbody>
</table>

### School covariates

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Estimate</th>
<th>SE</th>
<th>CI Lower</th>
<th>CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender ratio</td>
<td>-0.03</td>
<td>0.02</td>
<td>(-0.08/0.00)</td>
<td></td>
</tr>
<tr>
<td>Average age</td>
<td>-0.03</td>
<td>0.10</td>
<td>(-0.20/0.11)</td>
<td></td>
</tr>
<tr>
<td>Team size</td>
<td>-0.14</td>
<td>0.08</td>
<td>(-0.26/0.03)</td>
<td></td>
</tr>
<tr>
<td>Number of students</td>
<td>0.10</td>
<td>0.06</td>
<td>(-0.03/0.19)</td>
<td></td>
</tr>
<tr>
<td>Team experience</td>
<td>0.42**</td>
<td>0.14</td>
<td>(0.09/0.64)</td>
<td></td>
</tr>
<tr>
<td>Socio-economic status (SES)</td>
<td>0.01</td>
<td>0.02</td>
<td>(-0.03/0.03)</td>
<td></td>
</tr>
</tbody>
</table>

### Random effects

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Estimate</th>
<th>SE</th>
<th>Covariance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sender variance</td>
<td>8.05</td>
<td>2.29</td>
<td>2.41</td>
</tr>
<tr>
<td>Receiver variance</td>
<td>1.74</td>
<td>0.42</td>
<td>1.57</td>
</tr>
<tr>
<td>Nominator-target variance</td>
<td>1.30</td>
<td>0.82</td>
<td>-0.99</td>
</tr>
</tbody>
</table>

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001

11,241 dyadic relations from 316 educators of 13 Dutch elementary schools.

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1 Gender ratio is calculated as the percentage of female team members

2 SES is calculated as the weighted percentage of students for whom the school receives extra financial resources
Chapter 2

The effect of school level demographics on work discussion relationships
While the first model examined the influence of individual demographics without taking demographic differences between schools into account, in Model 2 we added school level demographics to the equation. This analysis will provide insights in how characteristics of schools may affect the probability of ties above the influence of individual demographics. To recall, our hypotheses were that teachers have a higher likelihood to send and receive relationships in a school team with 3a) a higher female gender ratio, 3b) a higher average age, 3c) more years of shared team experience, 3d) fewer students (low number of students), 3e) fewer educators (small team size), and 3f) low SES. Given that all standard errors in Model 2 are rather high, the model appears not to have reached optimal convergence (Zijlstra & Van Duijn, 2005). Therefore, the results of model 2 should be interpreted with caution and the outcomes have to be regarded as a first exploration that requires additional tests.

Results for the school level demographics suggest a positive effect of overall team experience on the probability of relationships in school teams. In other words, the more experience a school team had in their current formation, the more likely relationships were formed around work related discussion. Other school level demographics appeared not to affect teachers’ probability of sending or receiving relationships around work discussion above and beyond the prediction of relationships from individual and dyadic demographic variables. As such, only hypothesis 3e could be confirmed. When taking school demographics into account, results indicate some changes in the significance of individual and dyadic level parameters. For instance, results suggest significant sender effects of the individual demographics grade level and gender. Since both parameters are positive, this means that the upper dummy codes for grade level and gender have a higher probability of sending ties than the lower dummy codes. In this case, findings thus suggest that educators from upper grade tend to send out more relationships than educators that teach lower grade. However, they do not receive more relationships, as evidenced by a non-significant receiver effect. Also, female educators appear to send more relationships than male educators, but mail educators receive more relationships than female educators, signified by the significant negative receiver parameter for gender. These findings partially support Hypotheses 1a and 1f when taking school level network differences into account. Surprisingly, findings also indicate negative receiver effects for educators that work fulltime, educators with more experience at the school, and older educators. Meaning, educators with these demographics were less likely to receive work-related relationships. Also, principals were not more likely to send or receive
relationships than teachers. As such, these findings contradict respectively Hypotheses 1b, 1c, 1d, and 1e.

The change of a positive effect of teacher experience at school in Model 1 into a negative effect in Model 2 may be evidence of a suppression effect due to the inclusion of school demographics, and in particular, the significant effect of team experience. Team experience and teacher experience at school may be correlated, which may explain why team experience would suppress an individual level effect of experience. When taking team experience into account, the amount of (individual) experience at school decreases teachers’ likelihood of receiving relationships. Moreover, the significant receiver effect for principals disappears under the influence of school demographics, but this may occur due to an overestimation of the standard errors, since the absolute value of the parameter estimate is similar in both models. At the dyadic level, again homophily effects could be confirmed for gender and grade level, thus supporting Hypotheses 2a and 2b when taking school level network differences into account.

CONCLUSIONS AND DISCUSSION

The field of educational research into social networks among educators is expanding rapidly. While studies are focusing on the potential effects of social networks for a variety of school outcomes, insights in the social forces that shape social network structure are limited. Especially in the field of education, where teachers play such a vital role in achieving school outcomes and where the expectations and stakes for collaborative initiatives are high, we need to understand how efforts to optimize these collaborative initiatives may be supported or constrained by inflexible factors, such as demographic variables. In support of this goal, this study examined 316 teachers of 13 schools in a large district in The Netherlands. We explored probability of sending and receiving work discussion relationships was shaped by several plausible demographic variables at the level of the individual, the dyad, and the school. Our findings give rise to the discussion of multiple general themes. Implications for practice are woven into the themes, as they relate directly to the findings that are discussed. We end with the limitations of our study and directions for further research.
Individual demographics shape the probability of relationships in line with educational practice

The findings of this study, although not always in the way we expected, make sense in an educational context. For instance, results indicated that teachers from upper grade tend to send more relationships around work discussion than teachers from lower grade. It may well be that the teacher practice and lesson planning of upper grade levels require more coordination and interaction among these grade level members than among lower grade level members. Recall that we also found a homophily effect for grade level, which means that the ties that are sent out by upper grade teachers, would have had a higher probability of being targeted towards same-grade level peers. In other words, communication is more likely within grade levels than between grade levels. In addition, upper grade levels in The Netherlands receive additional lessons for half a day per week compared to lower grades, which may also explain the increased probability of upper level relational activity. In combination with physical proximity for teachers within grade levels and physical distance for teachers from different grade levels, educational practice offers ample explanations for our findings. Therefore, in creating and strengthening professional communities, it may be useful to attend to this grade level gap as a means to increase overall teacher interaction and the exchange of experience and expertise in support of continuing paths of learning throughout elementary education.

In line with research in other settings (Aldrich et al., 1989; Mehra, Kilduff, & Brass, 1998), female teachers tended to send more relationships, and male teachers were found to receive more relationships. In addition, against our expectation, full time employed teachers receive fewer relationships than part time employees. Again, this may be related to the amount of coordination that is needed to effectively ‘share’ teaching responsibility among two teachers. Although full time teachers probably spend more time at school, the work related discussion network is mainly dominated by relationships among part time educators. Part time teachers, as they spend less time at the school, may have to work ‘harder’ and send out more ties to find the information they need to perform their tasks. When aiming to increase teacher interaction in support of teacher professional development or school improvement, scholars and practitioners should be aware of the already increased burden of work related interaction on part time teachers.

It is striking that principals were not found to send more relationships than teachers. Especially with a general purpose network such as ‘work related discussion’, we would expect that principals would engage in more
relationships than teachers, especially given that the networks were on average rather scarce. One explanation could be that principals perceive interaction with teachers as such an integral part of their task, that they interpreted work related discussion differently than teachers. Principals in these schools may also have developed additional strategies that lower their burden of having to maintain too many relationships and draining their resources (Balkundi & Harrison, 2006), such as transferring leadership tasks to senior teachers or assistant principals. Another explanation may lie in the dual leadership role that principals have as general administrative manager and leading educational professional (Hughes, 1985). According to school leadership research, many principals are mainly occupied with performing their administrative role, even while they consider the educational role to be more desirable (Cuban, 1988; Lee, Smith, & Cioci, 1993; Leithwood, Begley, & Cousins, 1990; Stoel, 1994). It may well be that principals in the sample schools were more focused on their administrative roles than on leading content related discussions on instructional strategies and exchanging work related expertise. This finding points to the realization that principals do not per definition have a higher probability of sending or receiving relationships in a school team, which implies that there may be teachers who are ‘better positioned’ to convey information through the school team’s social network than the principal. Conversely, professional development initiatives aimed at increasing teacher interaction are advised to attend to both teacher interactions and the principal position in the school’s social network in raising awareness for the importance of having a solid structure of social relationships in place.

Findings suggest that older teachers, and teachers with more experience, receive fewer relationships around work related discussion than younger and ‘newer’ teachers. This finding contradicts our expectations. This study further suggests that years of experience at school is a stronger predictor of the probability of having relationships than age. Yet, age and experience at the school are likely correlated, just as team experience and average age may be related to their individual level counterparts. The same may also hold for gender ratio, gender similarity, and gender at the individual level. A suppression effect caused by adding similar parameters may explain the sign change of the parameter estimate of ‘experience at the school’ between models 1 and 2. Moreover, the difficulty at model convergence for model 2 may be in part due to this empirical overlap. Future research is therefore needed, and in following studies, scholars are advised to carefully select their demographics of interest.
Chapter 2

Individual and dyadic demographics shape networks to a larger extent than school level characteristics

Results further suggest that the demographics especially influence the reception of relationships, more than the sending of relationships. This finding implies that a social network is defined by certain ‘regularities’ that affect the flow of resources such as information, knowledge, and support. Two of these regularities are homophily effects for gender and grade level; educators clearly prefer same-gender work relationships over different gender relationships and they tend to maintain relationships within their grade level over relationships with teachers from other grade levels. This given is already used by some intervention programs that target teacher interaction at the grade level (Newmann, King, & Youngs, 2000). Yet, practitioners should be careful not to focus too much on solely building relationships at the grade level, since this may increase the potential of homogenous cliques that may consist of many strong but redundant ties, which inhibit the flow of new, complex knowledge in the network through weak ties that span grade levels and gender segregation lines (Burt, 1997, 2000; Hansen, 1999).

School level demographics were found to be much less important for the pattern of social relationships among teachers than were individual and dyadic characteristics. The only school level characteristic that affected the probability of individual relationships is school team experience. What has to be noted, however, is that the employed statistical models (p2) are only designed to examine dyadic network characteristics as dependent variables (Snijders, 2002). Yet, the included school demographic variables may also affect social network structure at a higher level than the dyad, for instance network centralization or the number and shape of triadic relationships. Recently, scholars have developed p* (ERGM) models, that may be used to examine these more complex social network questions. Since this study was aimed to provide a first exploration of the influence of demographics on social networks in school teams, such a complex approach did not fall within the scope of this study. Moreover, we did not use p* modeling as its estimation properties are limited (Snijders, 2002). There is a dearth of work examining the influence of ‘natural and inflexible’ demographics and other antecedents that may affect the probability of social relationships in school teams.

Limitations

While we see the potential of this study to guide social network research and intervention programs aimed at teacher interaction, we acknowledge its limitations. One limitation that may affect our findings is the role of network
perception in the self-report of social relationships. For instance, Baerveldt et al. (2004) found that the number of relationships that an individual reports is associated with the importance that an individual attaches to having relationships. Students who find it important to have friends at school, tend to report more relationships than those who attach less importance to having friends at school. This may potentially have biased the findings with regard to the sender effects of grade level and gender; upper grades and women may just find relationships more important, and that is why they report having more relationships. To counter this bias, it would be interesting to include the relative importance of having relationships as an individual attribute in subsequent studies into the influence of demographic variables on network structure.

Another limitation pertains to the level of generalization that is possible from our findings. Since the findings of this study contradict some findings in other settings, it is questionable whether our findings are generalizable to other contexts than Dutch elementary education. As mentioned before, Dutch schools are much smaller than U.S. elementary schools. Although we did not find effects of school size and team size on the probability of relationships in school teams, it may be possible that this is due to the relative homogeneous school and team sizes in our sample compared to potential differences in team size in other countries, such as the U.S. Therefore, this study should be valued as a first exploration of the influence of demographics on social network structure, specifically in regard to the school level demographics.

Social forces in school teams
This chapter emphasizes the importance of attending to demographic variables at multiple levels of analysis (individual, dyadic, and school) in efforts to further social network research and the implementation of collaborative initiatives in support of school improvement. These demographic variables represent the social forces upon which social network initiatives are layered. As such, insights in these demographics are vital to guide our expectations of networked interventions. Knowledge of the social forces that affect social networks enable practitioners to find ways to target social networks in school teams in such a way, that they are optimally equipped to transfer valuable resources through the school team in order to facilitate collective teacher action. One important clue to optimizing social network structure is that an unraveling network is not conducive to creating organizational benefits or supporting organizational change. Practitioners, educators, educational leaders, and scholars should first and foremost orchestrate the necessary conditions that promote network stability (Dhanaraj & Parkhe, 2006; Ebers & Grandori, 1999;
Chapter 2

Kenis & Knoke, 2002; Madhavan, Koka, & Prescott, 1998). This study shows that a potential route through which this can be achieved is to minimize school team turnover and increase school team experience. Since change experts and scholars can hardly intervene in any of the other demographic characteristics, they will have to design interventions and research that take into account these social forces that shape social networks in school teams. It is through the individuals behind these social forces, eventually, that change efforts optimize the potential of ties to affect teachers’ instructional practice and ultimately, student achievement.