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Instructional Advice and Information Seeking Behavior in Elementary Schools: Exploring Tie Formation as a Building Block in Social Capital Development

James P. Spillane
Professor, School of Education and Social Policy
Faculty Associate, Institute for Policy Research
Northwestern University

Chong Min Kim
Postdoctoral Fellow
Northwestern University

Kenneth Frank
Professor of Measurement and Quantitative Research Methods
Michigan State University

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Abstract

Education research consistently points to the importance of social capital in enabling instructional reform and school improvement. In schools and school districts, social relations can be a source of various resources including trust, expertise, opportunities for joint sensemaking, and incentives for innovation through peer pressure or sense of obligation. In this working paper, the researchers use data from 30 elementary schools in a mid-sized, urban U.S. school district to investigate social tie formation for advice and information-seeking regarding instruction in English Language Arts (ELA) and mathematics. The study's findings from multilevel p2 models suggest that while individuals' personal characteristics (e.g., race, gender) are significantly associated with tie formation, the formal organization (in terms of grade-level assignment and formal position) is also significant, having a larger effect than personal characteristics. The authors conclude by discussing their findings and possible entailments for research, policy, and practice.

The construct of social capital has garnered much attention in sociology, and in the sociology of education in particular. Building on and extending the work of Pierre Bourdieu (1986) and James Coleman (1988, 1990), scholars have theorized about social capital and empirically investigated its effects on valued outcomes. Though scholars focus on different aspects of social capital, the construct denotes real or potential resources for action that are attained *through relationships* (Bourdieu, 1986; Coleman, 1988; Lin, 1982, 2001). As Lin (2001) states, "social capital is the resources, real or potential, gained from relationships" (p. 23). These resources take various forms, including material goods and services, trust, information, social support, social obligation, and social norms (Coleman, 1988; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). Social capital differs from other forms of capital (e.g., human or physical capital) in that it is embedded in the relations among people. Both individuals and organizations can invest in, and benefit from, social capital (Ibarra, Kilduff, & Tsai, 2005).

Education research consistently points to the importance of social capital in enabling instructional reform and school improvement (Bryk & Schneider, 2002; Frank, Zhao, & Borman, 2004; Louis & Kruse, 1995; McLaughlin & Talbert, 2001; Rosenholtz, 1991; Smylie & Hart, 1999). In schools and school districts, social relations can be a source of various resources including trust (Bryk & Schneider, 2002; Louis, Marks, & Kruse, 1996), expertise (Daly & Finnigan, 2010; Frank et al., 2004; Spillane, 2004), opportunities for joint sense-making (Coburn, 2001; Spillane, 2004), and incentives for innovation through peer pressure or sense of obligation (Spillane, 2004).

Much of the literature on social capital has focused on the organization of social relations, the resources embedded within social networks, and the returns from investments in

social capital to both individuals and organizations (Lin, 1999). Research on schools, for example, has centered almost exclusively on the impact of social capital on valued school outcomes such as program implementation, instructional innovation, and student achievement (Bryk & Schneider, 2002; Frank et al., 2004; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Leana & Pil, 2006; Penuel et al., 2010; Penuel, Riel, Krause, & Frank, 2009; Supovitz, Sirinides, & May, 2010).

The existence of a network tie, however, is neither "a natural given" nor "a social given" (Bourdieu, 1986, p. 249). Rather, these ties are a product of individual or collective action. Yet few studies focus on identifying those factors that might account for differences in, or the development of, social capital at the individual, group, or organizational level (Coburn, 2001; Small, 2010). "The real weakness is the lack of both theory and empirical work focusing on the causes of social capital. If we are going to change the level of social capital, we must have a coherent model of the formation of social capital and a body of empirical work that we trust about the formation of norms and networks" (Glaeser, 2001, p. 381). A step in this direction involves understanding those factors associated with the existence of a social tie among actors in schools because, absent social ties, individuals do not have access to social resources.

In this paper, we investigate social tie formation in schools focusing on advice and information seeking in English Language Arts (ELA) and mathematics, the two core elementary school subjects. We examine the role of both formal organizational structure and of the personal characteristics of school staff in shaping advice and information seeking about instruction. We begin by situating our work in the empirical and theoretical literature on social capital and, based on that, define working hypotheses that guide our analysis. Next, we describe our data collection and data analysis in 30 elementary schools in a mid-sized urban U.S. school district. We then

present the results from a multi-level p_2 model (Van Duijn, Snijders, & Zijlstra, 2004; Zijlstra, Van Duijn, & Snijders, 2006). Our findings suggest that, while the personal characteristics (e.g., race, gender) of individuals are significantly associated with the formation of a tie, the formal school organization is also significant and has a larger effect than personal characteristics. We conclude by discussing our findings and considering their entailments for research, policy and practice.

Framing the Work

We anchor our paper in theoretical and empirical work on social capital and social networks. First, we justify our focus on advice and information flow in elementary schools. Second, we consider the theoretical and empirical literature on tie formation in general and articulate a series of working hypotheses that guide our analysis.

Advice and Information Flow: Social Interactions and Knowledge Development in Schools

Advice and information are fundamental building blocks for knowledge development, a critical ingredient for instructional improvement in schools (Elmore, 1996; Hill, 2004). As organizations, schools are knowledge intensive because of the complexity of the core technology of schooling – instruction (Cohen, 1988). This complexity is a function of variability in student needs and the uncertainty of teacher-student relations (Barr & Dreeben, 1983; Bidwell, 1965; Bidwell & Kasarda, 1987; Cohen, 1988; Meyer & Rowan, 1977), competing and often conflicting demands on schools from a segmented institutional environment (Bidwell & Kasarda, 1987; Honig, 2006; Schmidt et al., 2001) and disagreement about how best to teach, and the lack of homogeneity in teachers' preparation to teach (Lortie, 1975). Thus, the ongoing development of knowledge is critical in order that teachers can adapt their instructional practice to particular situations (Frank et al., 2011; Zhao & Frank, 2003).

Teachers can develop their knowledge through participation in professional development *and* through on-the-job learning opportunities (Parise & Spillane, 2010). Through participation in professional development, teachers encounter new information and get advice about teaching that can help them develop new knowledge that in turn may lead to change in instructional practice (Desimone, Porter, Garet, Yoon, & Birman, 2002; Garet, Porter, Desimone, Birman, & Yoon, 2001; Hill, 2007; Little, 1993). While formal learning opportunities have taken center stage for policymakers, teachers also develop new knowledge through their interactions with colleagues on the job. On-the-job learning happens when organizational members interact, asking questions and getting information, observing colleagues, and giving and receiving feedback (Eraut, 2004; Eraut & Hirsh, 2007; Frank et al., 2004). On-the-job social interactions are associated with the transfer of information and advice, which is essential for professional learning and knowledge development (Frank et al., 2004; Reagans & McEvily, 2003; Uzzi, 1997).

While *weak ties* are sufficient for transferring explicit or simple information (Hansen, 1999), strong ties are necessary for the transfer of tacit, complex, and sensitive information (Reagans & McEvily, 2003; Uzzi, 1997), the sort of information that is key for developing the knowledge that is often critical for improving classroom instruction. Strong ties also support joint problem solving among organizational members (Uzzi, 1997). With respect to tie span, interactions that span "multiple knowledge pools" (Reagans & McEvily, 2003, p. 242) reaching beyond their immediate grade level, or even school, allow school staff to access new information and spark innovation and creativity within the group (Ancona & Caldwell, 1992; Granovetter, 1983; Pelled, Eisenhardt, & Xin, 1999; Tsai, 2001). Without this access to outside information, groups can reinforce undesirable behavior and beliefs (Janis, 1983; Little, 1990). Teachers' intra-

school advice and information networks then are important to the ongoing development of knowledge about instruction inside schools. Although other teachers may possess important information, it may be difficult to access because teachers tend to practice as isolates with few opportunities to observe one another (Glidewell, Tucker, Todt, & Cox, 1983; Hargreaves, 1991; Little, 1990; Lortie, 1975). Still, the available evidence suggests that the more teachers can access related expertise through interactions with colleagues the more they are able to implement instructional change (Frank et al., 2004; Penuel, Frank, & Krause, 2007; Reiser et al., 2000).

In all of this work, social ties are critical; these ties are a *necessary* – if insufficient – condition for social capital development and deployment. Yet, few studies examine those factors that might account for the existence of a tie among school staff.

The Formation of Social Ties: Individual & Organizational Considerations

As captured by the familiar adage 'birds of a feather flock together,' individuals are more likely to interact with others who are similar to themselves with respect to characteristics such as age, race, gender, education, and values (McPherson, Smith-Lovin, & Cook, 2001, p. 417) (see also Ibarra, 1992; Mollica, Gray, & Trevino, 2003; Monge & Contractor, 2003). Scholars use the term 'homophily theory' to denote how individuals form ties with those who are like them and the theory is supported by two hypotheses (Monge & Contractor, 2003). First, the similarity-attraction hypothesis suggests that people are more likely to connect with individuals with similar characteristics (Bryne, 1971). Second, the self-categorization theory suggests that individuals categorize themselves and others based on traits such as gender, age, and race, using these categorizations to differentiate between similar and dissimilar others (Turner, 1987). The increased predictability of behavior and reduction in communication apprehension afforded by interpersonal similarities increases the likelihood that those who are alike will connect with one

another (Ibarra, 1992). Various studies offer empirical support that 'birds of a feather tend to flock together' especially with respect to race/ethnicity (Mollica et al., 2003; Shrum, Cheek, & Hunter, 1988), education (e.g., Marsden, 1987), gender (Ibarra, 1992; Leenders, 1996), and age (Feld, 1982). Based on this literature, we anticipate that teachers will be more likely to interact with colleagues of similar race, gender and career stage:

H_1: Teachers will be more likely to form new advice and information ties with colleagues of the same race, gender, and career stage.

Still, while the personal traits of organizational members may predict their ties with one another, social ties are embedded in organizations that make a difference to tie formation in that they bring people together who might not otherwise connect with one another. More important, the formal organizational structure is intended to enable and constrain interactions among organizational members (Blau, 1955; Blau & Scott, 1962). Aspects of the formal organizational structure such as formally designated positions (e.g., school principal, teacher), organizational sub-units (e.g., grade levels or departments), and formal organizational routines (e.g., faculty meetings, grade level meetings) both enable and constrain interactions among staff.

Schools as organizations seek to cultivate knowledge flow in order to support and coordinate teaching practices. The formal structure assigns people to particular positions and to sub-units that may more or less influence who they connect with, and they require participation in various organizational routines that bring organizational members into contact with some colleagues but not others (Adler & Kwon, 2002; Burt, 1992; Lin & Dumin, 1986; Spillane, Parise, & Sherer, 2011). In schools, for example, teachers typically work in grade-level or departmental sub-units, and tend to interact more frequently with colleagues in these sub-units (Bakkenes, De Brabander, & Imants, 1999; Bryk & Schneider, 2002; Daly, Moolenaar, Bolivar,

& Burke, 2010; Rowan, 2002). The formal school organizational structure may support advice and information flow within grades or departments for several reasons, including that teachers teach the same subject or curricular material, prepare students for the same tests, participate in the same organizational routines (e.g., grade level or department meetings), and/or their classrooms are located in close physical proximity to one another. Schools as organizations then contribute to, and constrain, the flow of advice and information by facilitating interaction among particular staff through assignment to sub-units and formal positions (e.g., coach, assistant principal), participation in formal organizational routines, among other things. Expecting the formal organizational structure to influence new ties we anticipate that:

H_2: School staff members with formally designated leadership positions are more likely to provide advice or information than staff without such formal leadership designations.

H_3: Teachers will be more likely to form new advice ties with members of their grade level teams than with other staff in their school.

Of course, all elementary schools are not organized identically. Some elementary schools, for example, may have a higher proportion of teachers who are specialists teaching one or two subjects across several grades rather than being confined to a single grade. Further, there is evidence to suggest that teacher communication patterns among teachers within schools varies depending on the grade (de Lima, 2007).

Another consideration in the formation of ties among school staff involves their participation in professional development. At one level, professional development can be thought about as part of the formal school organization in that school and district leaders establish structural conditions that can influence teachers' participation in professional development (Desimone et al., 2002; Louis & Kruse, 1995; Louis et al., 1996; Penuel et al., 2009; Youngs &

King, 2002). At another level, participation in professional development is also likely a function of individual characteristics – disposition to learn, innovate, and seek out new ideas. Savvy teachers are likely good at knowing who the instructional experts are in their school; they know who to reach out to for particular sorts of expertise. Under these circumstances, we might expect that information and advice would flow from those with more information and advice as measured by recent participation in more professional development in the school. Thus, we hypothesize that:

H_4: Teachers will be more likely to form new advice ties in either ELA or mathematics with colleagues who report attending more professional development in ELA or mathematics.

Our exploration of tie formation in elementary schools is framed by the four working hypotheses we articulate above based on our review of the literature. At the same time, in our analysis we allowed for the emergence of other findings not captured by these hypotheses.

Research Methodology

Sample

Data for this analysis are drawn from a larger study of school administration in one mid-sized U.S. public school district we name Cloverville. Staff members at each of Cloverville's 30 schools completed a questionnaire in the spring of 2005 and again in the spring of 2007.[1] Of the 1,356 elementary school staff members in the sample in 2005, 1,210 completed the survey, for an 89% response rate, though the response rate ranged from 66% to 100% by school. Of the

[1] Not included in the survey sample are art, music and computer teachers, paraprofessionals, administrative secretaries and clerks, social workers, psychologists, and food service workers. Notably, the principal did not complete this survey. However, this did not prevent staff members from naming their principal, or any other colleague not part of the sample, as an individual from whom they seek instructional advice.

1,436 elementary school staff members in the sample in 2007, 1,194 completed the survey for an 83% response rate, though the response rate ranged from 63% to 100% by school.

[Insert Table 1 Roughly Here]

In the 2006-2007 academic year, on average, schools enrolled 540 students, ranging from a low of 354 to a high of 870 (see Table 1). On average, 58% of students were African American across the 30 schools, ranging from 0% to 90%; 59% of students received free or reduced lunch, ranging from 10% to 90%. In addition, three schools had more than 10% English language learners (ELLs). On average, 93% of school staff members were female across the 30 schools, ranging from 80% to 98% depending on the school. Seventy-one percent of school staff members were white, ranging from 32% to 93%. Over one-third (36%) of respondents in our sample were new staff members after the 2004-05 school year, ranging from 14% to 62% depending on the school. The average number of years of teaching experience across the sample was 13 (see Table 1).

On average, 9% of respondents reported not teaching a class in 2007, ranging from 0% to 20% depending on the school. These staff members occupied full-time formal leadership positions, including assistant principal, ELA coordinators, and mathematics coordinators. Sixty-three percent of school staff reported being self-contained teachers teaching a single grade in 2007, ranging from 18% to 78% depending on the school. Twenty-eight percent of school staff reported teaching multiple grades, ranging from 8% to 74% depending on the school. On average across the 30 schools, 21% of school staff reported teaching the same grade level both in 2005 and 2007, though this varied from 6% to 39% depending on the school. Over half of our sample (56%) taught a different grade in 2007 than in 2005, though this varied by school and ranged from 24% in one school to 86% in another (see Table 2).

[Insert Table 2 Roughly Here]

Data Collection: Staff Questionnaire

The school staff questionnaire included two socio-metric questions regarding respondent's instructional advice seeking behavior. Specifically, the questions ask, "To whom do you turn in this school for advice or information about mathematics instruction?" and, "To whom do you turn in this school for advice or information about reading/language arts or English instruction?" Participants could write the names of up to seven colleagues in spaces provided and were also instructed that it was not necessary to fill in all seven spaces. Other questions on the staff questionnaire measured various aspects of the school organization including school norms (e.g., teacher-teacher trust, collective responsibility), school leadership (e.g., the formally designated leadership positions to which they were assigned), professional development and school change (e.g., opportunity to learn, change in instructional practice), and personal characteristics (e.g., race, gender).

With respect to the validity of these items, we want to make some observations. First, while we recognize the implications of limiting respondents to naming seven advisors, we believe that this limitation does not undermine the validity of our results because only four of the 1210 respondents (0.3%) in mathematics and only five respondents (0.4%) in ELA networks in 2005 listed seven advisors. In 2007, only six of the 1194 respondents (0.5%) in mathematics and only five respondents (0.4%) in ELA filled out seven advisors. Second, two pilot studies on versions of these social network items suggests that, overall, these items generate valid accounts of advice and information interactions among elementary school teachers (Pitts & Spillane, 2009). Analysis of data from one of these studies, for example, involving a 'think-a-loud' design, indicated that teachers interpreted the question, "To whom have you turned for advice or

information about teaching (subject X)" as intended by the researchers, describing interactions that were focused on instruction and explicitly distinguishing them from other interactions that were not focused on teaching. Further, as interviewees described the kinds of advice they received from the people they listed, they tied their descriptions back to the particular subject they had been asked about.

Informed by our review of the literature and our four working hypotheses, we considered seven dimensions – both individual and organizational characteristics – to explore those factors that might be associated with an information or advice tie between two staff members in ELA and mathematics. Personal characteristics of individual staff included in our model were race, gender, and career stage (Monge & Contractor, 2003). With respect to the formal organization, we included grade level assignment and formally designated leadership position. In addition, we included respondents' participation in formal professional development, which we suspect includes a combination of both organizational and personal characteristics.

Measures

Our dependent variable is the existence of an advice or information tie between two staff members about either mathematics or English language arts in the 2006-07 school year. For every pair of school staff *i* and *j*, if *i* turned to *j* for advice about instruction the $i \rightarrow j$ relationship was assigned a value of 1 and 0 otherwise.

Personal Characteristics

To examine H_1, the influence of personal characteristics, we used three variables: race, gender, and career stage, as follows:

Same race dyadic covariates: This dyadic indicator takes a value of 0 if two teachers were different races, 1 if they were the same race.

Same gender dyadic covariates: This dyadic indicator takes a value of 0 if two teachers were different genders, 1 if they were the same gender.

Career stage: We recoded responses to the question, 'How many years have you worked as a teacher?' using six categories derived from work on career stage (1=0-3 years, 2=4-6 years, 3=7-11 years, 4=12-20 years, 5=21-30 years, and 6=more than 30 years).

Formal Organizational Structure

To investigate the effect of formal organizational structure on new tie formation (hypothesis 2 and 3), we used same grade taught, multiple grades taught, and formally designated leadership position in 2007, as follows:

Same grade taught in 2007: This dyadic indicator takes a value of 0 if two teachers did not teach the same grade, 1 if they taught the same grade. For example, if a teacher A teaches 2nd grade, and a teacher B teaches 2nd and 3rd grades, then teachers A and B teach the same grade level. If teacher A teaches a single or multiple grade levels and teacher B teaches a single or multiple grade levels, and there is overlap in the grade levels they teach, then these two teachers teach the same grade level.

Multiple-grades taught in 2007: Teachers were asked to indicate what grade levels they taught at their schools. Teachers who reported teaching more than one grade level in 2007 were recoded as multiple-grade teachers.

Formally designated leaders in 2007: We coded responses to the survey question 'Are you formally assigned to perform a leadership role at this school as assistant principal, reform program coach/facilitator, subject area coordinator or chair, master/mentor teacher, or program coordinator (for example Title 1 coordinator)?' assigning staff who responded yes as formally

designated leaders in 2007. Please note that some of these respondents also had teaching responsibilities.

Professional Development

To explore hypothesis four, we measured professional development in 2007 using respondents' reports of their professional development in ELA and mathematics. We calculated two measures:

Professional development in 2007: The survey asked respondents to indicate how many professional development sessions they participated in this year focused on Mathematics teaching and Reading/Language Arts or English teaching (separately). The variable was scaled from 0 to 3 for each school subject (0=none, 1=1-2 sessions, 2=3-7 sessions, and 3=8+ sessions).

Difference in professional development for mathematics or ELA in 2007: This dyadic indicator uses a value of the difference between two staff members on their reported professional development for either mathematics or English language arts in 2007.

Control variables

We were able to control for the existence of a prior tie between two staff members in 2007 using the 2005 network data. We also controlled for teachers who were new in 2006 or 2007.

Previous network in 2005: Previous network was the existence of a tie or connection between two staff members about either mathematics or language arts in 2005. For every pair of school staff *i* and *j*, if *i* turned to *j* for advice about instruction in 2005, the $i \rightarrow j$ relationship was assigned a value of 1 and 0 otherwise.

New teachers after 2005: Teachers were asked to indicate how many years they have taught at their schools. Teachers who responded less than two years were recoded as new teachers.

Data Analysis

Individual-level factors refer to characteristics of the individual staff members (e.g., race, gender, career stage), whereas dyadic factors focus on similarities and differences between any two staff members (e.g., same gender or race). Observed dyadic interaction, then, is seen as a function of both individual and dyadic factors.

P_2 Model

Network selection models attempt to explain the pattern of ties among a group of individuals. Ordinary logistic regression is not appropriate here because social network data do not satisfy the assumption of independent observations because the tie from teacher *A* to teacher *B* is not independent of a tie from teacher *B* to teacher *A* (Van Duijn & Vermunt, 2006). P_2 models take into account the non-independence of social network observations (Van Duijn et al., 2004). The p_2 model can be thought of as a logistic regression model for the presence or absence of ties among any two actors in a network (Veenstra et al., 2007) and has been used to examine support networks of Dutch high school students (Zijlstra et al., 2006) and the effect of ethnicity on friendship among high school students (Baerveldt, Van Duijn, Vermeij, & Van Hemert, 2004; Baerveldt, Zijlstra, de Wolf, Van Rossem, & Van Duijn, 2007).[2]

[2] The parameters of the p_2 model are not computed directly but instead are generated using a Markov Chain Monte Carlo (MCMC) estimation algorithm (see Van Duijn et al., 2004; Zijlstra, Van Duijn, & Snijders, 2005; Zijlstra et al., 2006). We used 4,000 as burn in and 10,000 as sample size in the MCMC estimation.

The p_2 model expresses the pattern of observed ties as a function of characteristics of the dyad and of each member of the dyad. As such, dyads are nested within nominators and nominees, creating a cross-nested multilevel model. At level one are dyads, and at level two these pairs are cross-nested within providers and receivers (Crosnoe, Frank, & Mueller, 2008; Frank & Zhao, 2005; Frank et al., 2004). In our p_2 models, $advice\ or\ information_{ij}$ was used as the dependent variable, indicating whether teacher *i* reported seeking advice or information from teacher *j*. Then $advice\ or\ information_{ij}$ is modeled as a function of the tendency for teacher *j* to provide advice or information (α_j) and the tendency for *i* to receive advice or information (β_i). The model at level 1, for the pair of teachers *i* and *j*, is:

Level 1 (pair):

$$log\left(\frac{p[Advice\ or\ information_{ij}=1]}{1-p[Advice\ or\ information_{ij}=1]}\right) = \alpha_j + \beta_i$$

To identify different bases of structuring, dummy variables were included, indicating whether teachers had a tie in 2005, were the same race or the same gender, and whether they taught the same grade. In addition, the difference between two staff members' levels of professional development in either mathematics or language arts in 2007 was included. We also included reciprocity to control for the extent to which teacher *j* provided advice or information to teacher *i*.

The level 1 model is:

$$log\left(\frac{p[Advice\ or\ information_{ij}=1]}{1-p[Advice\ or\ information_{ij}=1]}\right) = \alpha_j + \beta_i + \delta_1\ (\text{prior relationship})_{ij}$$

$$+ \delta_2\ (\text{same race})_{ij} + \delta_3\ (\text{same gender})_{ij}$$

$$+ \delta_4\ (\text{same grade taught})_{ij} + \delta_5\ (\text{difference in professional development})_{ij}$$

$+ \delta_6$ (reciprocity: advice_{ji}).

Generally, the positive effect of an individual or dyadic characteristic indicates that the characteristic increases the probability of a tie (Baerveldt et al., 2004; Van Duijn et al., 2004; Veenstra et al., 2007). Specifically, the larger the value of δ_1, the more we would infer that the current ties in advice and information sharing are affected by previous ties. The larger the value of δ_2 and δ_3, the more we would infer that the patterns of advice or information sharing are influenced by the personal characteristics as defined by same race or same gender. The term δ_4 quantifies how the formal organization as represented by grade level shapes advice or information ties, and the term δ_5 quantifies how the difference in professional development shapes advice or information ties. Finally, the term δ_6 indicates the extent to which teachers mutually exchange advice and information.

We modelled the tendencies of teachers to be chosen as providing and seeking advice or information at a separate level:

Level 2a (*j*: provider of advice or information)
$\alpha_j = \gamma_0^{(\alpha)} + u_{0j}$.
Level 2b (*i*: receiver of advice or information)
$\beta_i = \gamma_0^{(\beta)} + v_{0i}$.

Here, the random effects u_{0j} and v_{0i} are assumed to be normally distributed and account for dependencies associated with tendencies to provide or receive advice or information that affect all relations in which a given individual engages. To estimate what attributes of the provider and receiver of advice or information predict a tie, new teachers, multiple-grade teacher, and formally designated leaders were included in provider effects in level 2a, and career stage and professional development were included in receiver effects in level 2b.

The level 2 model is:

Level 2a (*j*: provider effect)

$\alpha_j = \gamma_0^{(\alpha)} + \gamma_1^{(\alpha)}$ New Teachers $_j + \gamma_2^{(\alpha)}$ Multiple-grade teachers $_j + \gamma_3^{(\alpha)}$ Formally designated leaders $_j + u_{0j}$.

Level 2b (*i*: receiver effect)

$\beta_i = \gamma_0^{(\beta)} + \gamma_1^{(\beta)}$ career stage $_i + \gamma_2^{(\beta)}$ Professional Development $_i + v_{0i}$

Additionally, a random density effect (omega) across 30 schools was included in the multilevel p2 model, which indicates whether or not there was variation in the intercepts ($\gamma_{0)}$ across 30 schools. To aid interpretation of statistical significance, quantiles from the distributions of estimation samples are reported alongside each parameter estimate in the results tables. The quantiles between 0.25 and 97.5 define the Bayesian analogue to a frequentist confidence interval. Therefore, if the quantiles between 0.25 and 97.5 do not include 'zero', the estimate will be statistically significant.

Limitations

Our analysis has several limitations. First, the patterns of ties we identify may be a function of some unobservable or unmeasured variables. Although we control for prior ties, our analysis relies chiefly on a cross-sectional analysis and thus has limitations with respect to identifying causal relations. Second, although we measured professional development in ways particular to the two core elementary school subjects, we do not know whether professional development was required by the school or school district or is mostly a function of teachers' personal preferences. Further, our measure of professional development is based on number of sessions attended, though we have no way of determining the duration of a session. Third, an

exclusive focus on dyadic interactions has limitations because factors beyond the dyad can influence dyadic interactions. Consider three elementary teachers *A*, *B*, and *C*. While a dyadic-focused analysis can provide insight into the factors associated with the patterns of interactions among any pair of these three teachers, it fails to take into account that relationships between any pair is influenced by their connections to the third teacher (Snijders, Pattison, Robins, & Handcock, 2006). Still, some recent research suggests most of the structure of triads can be explained by lower-order properties – individual and dyadic (Faust, 2007).

Our analysis is also limited with respect to the generalizability of our findings about tie formation because we rely on data from 30 elementary schools in a single mid-sized urban school district. Thus, making claims about elementary schools in general in the state in which Cloverville is located or elementary schools in the U.S. is beyond the scope of our analysis. At the same time, considering that our analysis is in the theory building, hypotheses generating tradition rather than hypotheses testing, our sample is appropriate in that we include all 30 schools from a single school district. By including all schools, rather than a sub-sample, we maximize the variation in our sample on conditions that might account for tie formation while at the same time holding constant the school district policy context that might also influence tie formation. Maximizing variation is critical in theory building, hypotheses generating work. Still, we acknowledge that future work will undoubtedly offer more empirical insights on the critical issue of tie formation in schools.

Results

We report on findings from our multi-level p_2 models for mathematics and reading separately below, identifying those factors that are associated with the occurrence of a tie between any two staff members across the 30 schools in our sample. In order to give readers a

sense for what these findings might mean for the "average" Cloverville teacher's advice and information seeking behavior, we also calculated from the models probability tables for teachers' ELA and mathematics advice and information seeking. We present and discuss these findings only for ELA, as the probabilities were consistent across the two subjects.

Modeling Instructional Tie Formation in Schools

The models presented in Table 3 show the likelihood of advice-seeking ties between two colleagues as a function of provider characteristics, receiver characteristics, and dyadic characteristics determined by provider-receiver similarities based on data from our 30 schools. Provider effects refer to attributes of the provider of advice or information that account for the observed patterns in teachers' networks. Receiver effects refer to attributes of the receiver of advice or information that account for the observed patterns in teachers' networks. Dyadic effects refer to the extent to two teachers *with mutual attributes* have a tie in advice and information sharing. We conducted separate analysis for mathematics and language arts because prior work suggests that how elementary teachers think about their work and how they organize for instruction depends on the school subject (Spillane, 2000, 2005; Stodolsky, 1988).

Mathematics Ties

Our analysis found that personal characteristics influenced advice or information flows about mathematics instruction among Cloverville's elementary school teachers, controlling for a tie from a prior school year. Specifically, similarity of race and gender were associated with the emergence of a new advice or information tie among staff. Teachers of the same race were more likely to receive or provide advice or information from one another than those of different races, as suggested by a positive dyadic effect of same race (0.45) (See Table 3). Similarly, teachers and school leaders were more likely to receive or provide advice or information from a colleague

of the same gender, as suggested by a positive dyadic effect of same gender (0.41). Our analysis also suggests that career stage matters, with more experienced teachers less likely to receive advice or information about mathematics than their less experienced colleagues, as indicated by a negative receiver effect of career stage (-0.25). The small positive values of 0.45 and 0.41 of same race and gender indicate that having the same personal characteristics raises the odds of having a current tie by over one half.[3] All three results – race, gender, and career stage – are statistically significant.

[Insert Table 3 Roughly Here]

Still, our analysis also suggests that personal characteristics are only part of the story; the formal organization also mattered with respect to mathematics advice or information seeking. First, school staff members with formally designated leadership roles were more likely to provide advice or information, as reflected in a positive provider effect of formally designated leaders (1.28). Second, teachers who reported teaching across multiple grades were less likely to provide advice or information, compared with teachers who reported teaching one grade level or no specific grade level, as reflected in a negative provider effect of multiple-grade teachers (-1.85). Third, teachers in the same grade were more likely to receive or provide advice or information as reflected in a positive dyadic effect of same grade taught (3.02, exceeding the .05 threshold in the posterior distribution). This suggests that the formal organizational structure influenced the formation of advice or information ties among school staff in at least three ways – formal leadership designation, a teaching assignment that cut across grades, and grade level assignment.

[3]We used odds to compute the following formula: $e^{0.41}$-1=1.51-1=0.51=51% for same race, and 57% for same gender.

Professional development also had a significant effect on advice or information seeking behavior among school staff in the 30 elementary schools. Specifically, a positive receiver effect of professional development (0.88) suggests that teachers who reported more professional development in mathematics were more likely to receive advice and information about mathematics. This suggests an inclination to seek help either through formal professional development or informally through interactions with colleagues. Finally, a negative dyadic effect of difference in professional development (-0.35) suggests that teachers were more likely to receive advice or information about mathematics from teachers who reported more professional development in mathematics. This offers support for our working hypothesis that information and advice in schools may flow from those with information, as measured by recent participation in professional development, to those with less information, assuming that those who have more professional development have more information than those who have less professional development.

English Language Arts (ELA) Ties

Our findings for ELA are similar to those reported above for mathematics. In addition to reporting the findings from our p_2 model for ELA below, we report on the probability tables for ELA advice and information seeking that we constructed from the model. We constructed these tables in order to gauge the effect of the personal characteristic, organizational structure, and professional development variables on the probabilities of the four different dyad outcomes. These probabilities give us a more concrete sense of what various combinations of the variables (e.g., being in the same grade but of different race) might mean for the "average" Cloverville teacher's advice and information interactions.

Similar to mathematics, we see that both individual characteristics and aspects of the formal organization are associated with advice and information interactions related to English Language Arts (ELA). Specifically, a positive dyadic effect of same race (0.58) indicates that staff members of the same race were more likely to receive advice or information from one another than staff members of different races. A positive dyadic effect of same gender (0.31) indicates that advice and information flows were more likely to occur between staff members of the same gender than those of different genders. A negative receiver effect of career stage (-0.24) indicates that, the more experienced teachers are, the less likely they are to receive advice or information about ELA instruction. Both race and career stage effects are statistically significant, but same gender is not.

While personal characteristics matters, the formal school organization was also associated with the existence of an advice or information tie. Specifically, school staff members with formally designated leadership positions were more likely to provide advice or information than those who did not have such designations as reflected in a positive provider effect of formally designated leaders (1.06). Similar to mathematics, staff teaching multiple grade levels were less likely to provide advice or information than those who did not teach across grade levels as reflected in a negative provider effect of multiple-grade teacher (-2.15). In addition, a positive dyadic effect of same grade taught (3.20) indicates that receiving and providing advice or information about ELA is more likely for teachers teaching in the same grade level.

Again, similar to mathematics, a positive receiver effect of professional development (0.72) indicates that teachers who report more professional development in ELA were more likely to receive advice and information about ELA from colleagues. It is important to remember here that it is professional development related to ELA, rather than just professional development

in general, that is associated with more advice and information flow. Finally, a negative dyadic effect of difference in professional development (-0.32) suggests that teachers were more likely to receive advice or information about ELA from teachers who reported more professional development in ELA. Again, this supports our fourth hypothesis that information and advice in schools may flow from those with greater expertise to those with lesser expertise, assuming that those with more professional development in the particular subject have more expertise in that subject.

What might these effects mean in concrete terms?

As noted above, to gain a more concrete sense of what these effects might mean, we constructed probability tables for ELA advice and information seeking from the p_2 model. Each of the two-by-two cell blocks in Tables 4 and 5 show the probabilities of each possible dyad outcome (00, 01, 10, 11) for pairings of staff. While 00 indicates that no tie existed, 11 indicates a reciprocated tie, and both 01 and 10 indicate a tie where one person in the dyad received advice from the other but the exchange was not reciprocated. Ignoring random effects, we infer the effect of the variables on the probabilities of the different dyad outcomes from our p_2 model. In other words, these are the expected probabilities for an 'average' teacher with the characteristics tested in the model. As noted above, the expected dyad probabilities of mathematics advice and information ties were similar to those for that we report below ELA.

Race, gender, previous ties, and same grade

From Table 4, we get a sense of the relative effect of personal characteristics and same grade assignment (an aspect of the formal organization) in ELA advice or information seeking behavior for an 'average' Cloverville teacher with the characteristics in our model. If two teachers, *without* a formally designated leadership position, have a prior ELA advice and

information tie, teach in the same grade, and are of the same race and gender, the probability of having a tie is 100%. Further, the same two teachers would have a 74% chance of having a reciprocal relationship with respect to ELA advice and information. Two teachers, neither with a formally designated leadership position, but having a prior ELA tie, teaching in the same grade, of the same gender but of different races still had a 100% chance of having a tie. Even if two teachers without formally designated leaderships were of different races and different genders, but taught in the same single grade, the probability of having a tie was 100%. Overall, this suggests that there are no effects of race and gender on ELA ties when two teachers have a prior tie and teach in the same grade. Thus, the formal organization in terms of grade level assignment trumps race and gender homophily.

The situation changes, however, when we remove the constraints of the formal organization in terms of grade level assignment. Specifically, the effects of race and gender become much more pronounced when we consider the formation of a tie between teachers in different grades. If two teachers, without any formal leadership position, of different race and different gender and teaching in different grades, the chances of having any sort of ELA tie (i.e., reciprocal or one-way) is 76% if they *had a prior ELA advice and information tie*. This speaks to the continuity of advice networks, although the relationship is not as strong as when the teachers share commonality of race, gender or grade taught.

A recurring theme here is the critical importance to tie formation of either having a tie from a previous school year or teaching in the same grade in the current school year. Specifically, if two teachers with no formal leadership positions and who have no previous ELA advice or information tie, teach the same grade and are of the same race and gender, their chances of having a tie is still very high at 98%. Even if these two ‘average’ teachers are of

different race and different gender, their probability of having an ELA tie drops just 9%, to 89%. Most striking, if these two same 'average' teachers in Cloverville were teaching different grades, regardless of race and gender, the probability of having a tie is less than 8%. Thus, in the absence of a prior ELA tie, teaching in the same grade is critical in the formation of an ELA tie. It is in this sense that grade level generates new informal relationships, integrating the formal and informal organization.

[Insert Table 4 Roughly Here]

Professional development, previous ties and same grade

As we discussed above, professional development was also a statistically significant factor in tie formation. So, we calculated the expected dyad probabilities of ELA ties with respect to professional development in ELA, previous ties, and same grade for teachers of the same career stage, same race, and same gender (See Table 5). Table 5 gives us a more concrete sense of the effects of formal professional development and grade level assignment on teachers' ELA ties. Specifically, if two teachers with no formal leadership position have a prior ELA tie and teach the same grade they have a very high probability of having a tie, regardless of their professional development. Under these circumstances, professional development has no effect on ELA tie formation, wiped out by the powerful effects of prior tie and same grade assignment. However, professional development increases the chances of two teachers having a tie when they either teach at different grades *or* have no previous ELA tie. (Keep in mind that in calculating these probabilities we 'controlled' for race, gender, and career stage). If two teachers have no prior ELA tie and teach in different grades, increases in the amount of ELA professional development they report improves the chances of them forming an ELA tie from 7% to 37 %.

[Insert Table 5 Roughly Here]

Discussion & Conclusion

Our analysis suggests that, while school leaders' and teachers' personal characteristics are associated with teachers' instructional advice or information flows, the formal organization in the form of grade level assignment, having a formally designated leadership position, and teaching a single grade trumps individual characteristics. Controlling for prior ties, our analysis shows that grade level assignment is strongly associated with the formation of a new tie. We might expect this finding for several reasons. In elementary schools, teachers teaching similar grades are typically located adjacent to one another, so physical proximity may increase the probability of forming a tie. But, physical proximity may be only part of the story. The significance of teaching the same grade may also reflect other aspects of the formal organizational structure such as organizational routines (Spillane & Coldren, 2011; Spillane et al., 2011). Teachers in the same grade, for example, are more likely to participate in more of the same organizational routines (e.g., grade level meetings), creating more occasions for teachers in similar grades to interact with one another than teachers in different grades (Frank & Zhao, 2005; Penuel et al., 2010). Further, teachers in the same grade level typically teach the same curricular content using the same curricular materials. These arrangements not only provide incentives to seek out advice and information from one another (e.g., relatively similar instructional goals and challenges), but also provide common artifacts around which teachers can interact (e.g., identical standards, similar student achievement data, same textbooks and curricula). Our current analysis is unable to pinpoint which combination of these mechanisms might be at play in accounting for the significant and strong effect of grade level assignment on advice or information seeking behavior. Still, our analysis suggests that assigning teachers to classrooms may be an important

means for school leaders wanting to shape instructional advice and information ties among staff. Overall, while personal characteristics matter, with school leaders and teachers more likely to interact with colleagues of the same race and gender, these effects were not nearly as strong as the formal organization.

Our findings have important implications for the social structures and resource flows within schools. Structurally, our findings imply that the density of advice and information interactions within grades increases over time. On the one hand, this enhances resource flows within grades as grade members develop a common language and norms for knowledge sharing (Nonaka, 1994; Yasumoto, Uekawa, & Bidwell, 2001). On the other hand, without deliberate intervention over time, the social dynamics we identified will generate social capital that will be distributed in clumps, rather than through uniform or even flows across the school. As a result, teachers of one grade level may not be able to access the knowledge possessed by those in other grades. Such segmented social capital can inhibit learning because learning and the knowledge necessary for successful teaching are not neatly compartmentalized in grades. A third grade teacher may have knowledge for teaching reading that has great value for her second or fourth grade colleagues.

The question, then, turns to the factors that generate between-grade ties. Here, we observe the importance of professional development, as teachers who report more subject-specific professional development are more likely to form an advice and information tie about that subject with a colleague and are more likely to be sought out by colleagues for instructional advice and information about that subject. This is important in that it suggests that the returns from professional development may not simply be direct returns in improving the knowledge and skill of those who attend but may also indirectly contribute to informal on the job learning,

especially to flows that are not necessarily contained within grade levels. On a more general level, formal professional development is just one example of an activity that administrators can employ to limit the compartmentalization of resources within grade level interactions. Administrators also might deliberately cultivate cross grade level interactions through vertical teams or cross-school committees.

Although formal professional development and informal on-the-job learning opportunities through interactions with colleagues may be closely related, based on the current analysis we cannot determine the direction of this relationship. It may be that teachers who seek out professional development are more disposed to learning in general so are also more likely to seek out opportunities to learn on the job from their colleagues. At the same time, it may be that formal professional development prompts teachers and/or gives them the resources (e.g., language) and know how to seek out their colleagues for advice and information. Of course, the reverse relationship is also plausible; through interactions with colleagues on the job, teachers get information and advice about formal professional development that they then pursue. But we did control for the presence of a prior tie, therefore favoring our initial interpretation. More work is needed on the relations between professional development and teachers' on-the-job opportunities to learn through interactions with colleagues (Parise & Spillane, 2010).

Some other reasons for caution have to do with several possible interpretations of the professional development findings. Teachers may perceive their colleagues who have more professional development in a particular school subject as having more knowledge about that subject and thus seek them out. Similarly, teachers with more professional development may be encouraged by their school leaders to relay the advice and information they gained through professional development back to their colleagues. An alternative scenario is that teachers who

are experiencing more instructional difficulty may seek out, or be pressured to attend by school leaders, more formal professional development and also seek more advice and information from their colleagues. This is supported in part by the finding that younger teachers are more likely to receive advice and information than their older, more experienced colleagues. Of course both scenarios are not mutually exclusive.

One take-away lesson for school leaders and district policy-makers concerns how we make decisions with respect to teachers' grade level assignments. If, as our analysis suggests, formal organizational structure can influence advice and information seeking behavior among school staff, then it seems that school leaders and district policymakers would be well advised to think carefully about how they distribute teachers across grade levels. Specifically, district or school leaders might ensure that 'master' or 'exemplary' teachers in any one school are dispersed across grade levels to maximize their potential influence on other teachers in their school. In this way, they would increase all teachers' access to the knowledge and expertise of exemplary or master teachers in their school. More striking, formal organization in the form of grade level appears to matter regardless of school subject, at least at the elementary level. While prior work suggests that elementary school teachers' instructional advice seeking patterns may differ by school subject (Hayton & Spillane, 2008; Spillane, 2006), our analysis suggests that formal structure is an important predictor of ties among teachers regardless of school subject.

Table 1. Student and School Staff Characteristics in 30 Elementary Schools in 2006-2007

Student	Minimum	Maximum	Mean	SD
Enrollment	354	870	540	132
African American	0%	90%	58%	29%
White	0%	70%	24%	24%
ELLs	0%	10%	1%	3%
Free or reduced lunch	10%	90%	59%	24%
School staff	Minimum	Maximum	Mean	SD
Full time	89%	100%	96%	3%
Female	80%	98%	93%	5%
White	32%	93%	71%	17%
New after 2005	14%	62%	36%	13%
Years of teaching experience	9	19	13	3
Professional development in mathematics	1.58	3.60	2.01	0.38
Professional development in ELA	1.73	2.84	2.20	0.28

Table 2. Grade types and change in grades level taught from 2005 to 2007

Grade types in 2007		Minimum	Maximum	Mean	SD
No grade level taught in 2007		0%	20%	9%	5%
Single grade level taught in 2007		18%	78%	63%	11%
Multiple grades level taught in 2007		8%	74%	28%	12%
Change in grades level taught from 2005 to 2007		**Minimum**	**Maximum**	**Mean**	**SD**
No previous ties	Same grade level taught	3%	24%	10%	5%
	Different grade level taught	21%	77%	42%	14%
With previous ties	Same grade level taught	0%	30%	10%	7%
	Different grade level taught	0%	30%	14%	7%
Total	Same grade level taught	6%	39%	21%	9%
	Different grade level taught	24%	86%	56%	14%

Table 3. Multilevel P_2 Models for 30 Elementary Schools

Mathematics Network	Parameter			Quantiles	
	$e^{estimate}$	estimate	S.E.	0.25	97.5
Receiver variance		1.98	0.27	1.56	2.55
Provider variance		1.76	0.22	1.40	2.24
Provider-Receiver covariance		-0.25	0.14	-0.53	0.02
Density		-7.24	0.62	-8.37	-6.13
Reciprocity		1.90	0.21	1.48	2.27
Omega for multilevel model		3.36	2.74	0.20	9.72
Receiver level					
Career stage	0.78	-0.25	0.05	-0.36	-0.15
Professional development in mathematics	2.41	0.88	0.11	0.63	1.09
Provider level					
New teachers	0.44	-0.83	0.20	-1.26	-0.51
Multiple-grade teachers	0.16	-1.85	0.17	-2.16	-1.48
Formally designated leaders	3.60	1.28	0.16	1.00	1.60
Dyadic level					
Difference in Professional development in math	0.70	-0.35	0.08	-0.50	-0.18
Previous mathematics tie	9.03	2.20	0.18	1.86	2.56
Same race	1.57	0.45	0.11	0.24	0.66
Same gender	1.51	0.41	0.18	0.04	0.77
same grade taught	20.49	3.02	0.13	2.77	3.29
Deviance		4048			
BIC		36376			
Newton-Raftery p4		-2033			
log-likelihood		-2403	35	-2471	-2335
ELA Network	Parameter			Quantiles	
	e^{estima}	estimate	S.E.	0.25	97.5
Receiver variance		1.63	0.19	1.26	2.02
Provider variance		2.23	0.24	1.80	2.74
Provider-Receiver covariance		-0.29	0.16	-0.63	0.02
Density		-6.76	0.65	-7.83	-5.59
Reciprocity		1.70	0.20	1.32	2.07
Omega for multilevel model		3.59	2.51	0.43	9.25
Receiver level					
Career stage	0.79	-0.24	0.04	-0.32	-0.15
Professional development in ELA	2.05	0.72	0.10	0.53	0.91
Provider level					
New teachers	0.46	-0.78	0.20	-1.22	-0.45
Multiple-grade teachers	0.12	-2.15	0.17	-2.46	-1.82
Formally designated leaders	2.89	1.06	0.15	0.77	1.32
Dyadic level					
Difference in professional development in ELA	0.73	-0.32	0.08	-0.46	-0.17
Previous ELA tie	15.64	2.75	0.17	2.42	3.11
Same race	1.79	0.58	0.10	0.38	0.78

Same gender	1.36	0.31	0.17	-0.03	0.64
same grade taught	24.53	3.20	0.13	2.92	3.43
Deviance		4286			
BIC		36614			
Newton-Raftery p4		-2152			
log-likelihood		-2547	34	-2617	-2483

Note: Sample size was 1142 after excluding missing values in career stage, professional development in mathematics or ELA, and new teachers.

Table 4. Expected dyad probabilities of ELA advice relationships of gender, race, previous tie, and grade.
(0,0) (0,1)
(1,0) (1,1)

Previous ELA advice network								
	Same grade				**Different grade**			
	Same race		*Different race*		*Same race*		*Different race*	
Same gender	0.00	0.13	0.00	0.13	0.04	0.13	0.15	0.11
	0.13	0.74	0.13	0.74	0.13	0.70	0.11	0.63
Different gender	0.00	0.13	0.00	0.13	0.09	0.12	0.24	0.10
	0.13	0.74	0.13	0.74	0.12	0.67	0.10	0.56
No previous ELA advice network								
	Same grade				**Different grade**			
	Same race		*Different race*		*Same race*		*Different race*	
Same gender	0.02	0.13	0.06	0.13	0.93	0.01	0.98	0.00
	0.13	0.72	0.13	0.68	0.01	0.05	0.00	0.02
Different gender	0.04	0.13	0.11	0.12	0.96	0.01	0.99	0.00
	0.13	0.70	0.12	0.65	0.01	0.03	0.00	0.01

Note: For teachers who are not new and have same career stage with no professional development. In addition, these teachers teach no multiple-grade level and are not formally designated leaders.

Table 5. Expected dyad probabilities of ELA advice relationships of PD
(0,0) (0,1)
(1,0) (1,1)

		Same Grade							
	PD	8+ PD		3-7 PD		1-2 PD		No PD	
Previous Tie	8+ PD	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.02
		0.15	0.83	0.15	0.83	0.15	0.83	0.15	0.83
	3-7 PD	0.00	0.04	0.00	0.04	0.00	0.04	0.00	0.04
		0.15	0.81	0.15	0.81	0.15	0.81	0.15	0.81
	1-2 PD	0.00	0.07	0.00	0.07	0.00	0.07	0.00	0.07
		0.14	0.79	0.14	0.79	0.14	0.79	0.14	0.79
	No PD	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13
		0.13	0.74	0.13	0.74	0.13	0.74	0.13	0.74
No Previous Tie	8+ PD	0.00	0.02	0.01	0.02	0.01	0.02	0.02	0.02
		0.15	0.83	0.15	0.82	0.15	0.82	0.15	0.81
	3-7 PD	0.00	0.04	0.01	0.04	0.01	0.04	0.02	0.03
		0.15	0.81	0.15	0.81	0.15	0.81	0.15	0.80
	1-2 PD	0.00	0.07	0.01	0.07	0.01	0.07	0.02	0.07
		0.14	0.79	0.14	0.78	0.14	0.78	0.14	0.77
	No PD	0.00	0.13	0.01	0.13	0.01	0.13	0.02	0.13
		0.13	0.74	0.13	0.73	0.13	0.73	0.13	0.72
		Different Grade							
	PD	8+ PD		3-7 PD		1-2 PD		No PD	
Previous Tie	8+ PD	0.01	0.02	0.01	0.02	0.02	0.02	0.04	0.02
		0.15	0.82	0.15	0.82	0.15	0.81	0.15	0.79
	3-7 PD	0.01	0.04	0.01	0.04	0.03	0.03	0.05	0.03
		0.15	0.80	0.15	0.80	0.15	0.79	0.14	0.78
	1-2 PD	0.01	0.07	0.01	0.07	0.03	0.07	0.05	0.07
		0.14	0.78	0.14	0.78	0.14	0.76	0.14	0.74
	No PD	0.01	0.13	0.01	0.13	0.03	0.13	0.05	0.13
		0.13	0.73	0.13	0.73	0.13	0.71	0.13	0.70
No Previous Tie	8+ PD	0.63	0.01	0.76	0.00	0.86	0.00	0.92	0.00
		0.06	0.30	0.04	0.20	0.02	0.12	0.01	0.07
	3-7 PD	0.64	0.01	0.77	0.01	0.86	0.00	0.92	0.00
		0.05	0.30	0.03	0.19	0.02	0.12	0.01	0.07
	1-2 PD	0.65	0.02	0.78	0.02	0.87	0.01	0.93	0.01
		0.05	0.08	0.03	0.17	0.02	0.10	0.01	0.05
	No PD	0.65	0.05	0.78	0.03	0.87	0.02	0.93	0.01
		0.05	0.25	0.03	0.16	0.02	0.09	0.01	0.05

Note: For teachers who are not new and have the same career stage, same race, and same gender.

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