

Breaking Up Isn't Hard to Do: Exploring the Dissolution of Teachers' and School Leaders' Work-Related Ties

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Abstract

Purpose: School leaders are central to the development of work-related ties among school staff. Although prior work has examined the predictors of the presence of work-related ties, little is known about the breakup or dissolution of ties among school staff. This study examines the extent of tie dissolution among school staff, as well as both the individual- and organizational-level predictors of the breakup of ties. **Research Methods:** This study uses social network analysis of 4 years of survey data from 14 elementary schools in one suburban U.S. district. Social network models predict the likelihood of the breakup of a tie between school staff in three types of networks: close colleague networks, and instructional advice networks in mathematics and language arts. **Findings:** Work-related ties between school staff dissolve at high rates from year to year, and ties that dissolve generally do not reform. Aspects of the formal school organization—particularly changing grade levels and losing leadership positions—predict the breakup of ties, while individual-level factors such as commitment to the school, perceptions of school leadership, and beliefs about instruction generally do not predict tie dissolution. **Implications for Research and Practice:** School leaders

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should carefully consider grade reassignments and changes in leadership positions, as these changes strongly predict the breakup of ties between school staff. School leaders should also invest in the promotion and maintenance of cross-grade ties after changes to grade-level assignments.

Keywords

school leaders, teachers, social ties, dissolution, network analysis

Social relations, a necessary condition for developing social capital, are potential sources of resources such as expertise, trust, and information, resources critical for instructional improvement (Bryk & Schneider, 2002; Coburn, 2001; Daly, Moolenaar, Bolivar, & Burke, 2010; Frank, Zhao, Penuel, Ellefson, & Porter, 2011; Louis, Marks, & Kruse, 1996; Moolenaar, Karsten, Slegers, & Daly, 2014). These social resources have also been linked to teacher productivity as measured in terms of student achievement, reform implementation, parental satisfaction, and student attendance (Leana & Pil, 2006; Pil & Leana, 2009; Penuel et al., 2010; Penuel, Riel, Krause, & Frank, 2009; Supovitz, Sirinides, & May, 2010). The social capital that resides in the relations or ties among school staff—both teachers and school leaders—is therefore critical for instructional improvement.

School leaders play a particularly central function in the development and maintenance of social capital in schools by creating teacher teams, assigning staff to leadership positions, and creating a climate of trust and respect among school staff, all of which encourage staff to work together and potentially develop social capital (Bryk, Sebring, Allensworth, Luppescu, & Easton, 2010; Kruse, Louis, & Bryk, 1995; Tschannen-Moran & Gareis, 2015). Consistent with a distributed perspective (Spillane, 2006), we use the term “school leader” to refer to school administrators such as school principals, specialists such as coaches, and teacher leaders such as grade-level leaders. In this article, when we refer to a particular type of school leader, such as the principal, we label them accordingly, but otherwise use the more inclusive school leader term. As external standards and accountability pressures have increased, school leaders have become even more important determinants of the work-related ties among school staff, with school leaders using organizational routines to “recouple” the work of schools to the demands of the broader educational system, shaping patterns of interaction among teachers and other staff (Hallett, 2010; Spillane et al., 2002; Spillane, Parise, & Sherer, 2011).

While the literature on social capital has focused mostly on the returns to social capital, some recent work explores those factors and mechanisms associated with the presence of work-related ties that are a necessary, if insufficient, condition for developing social capital (Coburn, 2001; Coburn, Choi, & Mata, 2010; Coburn & Russell, 2008; Frank, Zhao, & Borman, 2004; McPherson, Smith-Lovin, & Cook, 2001; Small, 2009; Spillane, Hopkins, & Sweet, 2015; Spillane, Kim, & Frank, 2012). Because ties are neither “a natural” nor “a social given” (Bourdieu, 1986, p. 249), understanding those factors associated with the presence of work-related ties, a prerequisite for facilitating access to social resources, is important so that research can inform social capital development.

Prior work sheds some light on the predictors of work-related ties. For example, one consistent finding, often termed “homophily,” is that ties are generally more likely to form between those that are similar in race, gender, age, education, and values (Feld, 1982; Ibarra, 1992; Leenders, 1996; Marsden, 1987; McPherson et al., 2001; Mollica, Gray, & Trevino, 2003; Monge & Contractor, 2003; Moolenaar et al., 2014; Shrum, Cheek, & Hunter, 1988). In schools, for example, the presence of instructional advice and information ties is predicted by aspects of the formal school organization, such as grade-level assignments and assignments to leadership positions (Spillane et al., 2012; Spillane et al., 2015). Thus, we focus on school leaders in general, as prior work examining work-related ties among school staff suggests that having any leadership function, rather than a particular type of position, is associated with having a tie (Spillane et al., 2015).

Over time, the constellation of work-related ties—and access to social capital—is defined not only by the formation of new ties but also by the dissolution of existing ties (Bridwell-Mitchell & Cooc, 2016). Yet there is a scarcity of research on tie dissolution. In this article, we focus on the dissolution of work-related ties among staff in all 14 elementary schools in one school district. We focus our analysis on three sorts of work-related ties: close colleague ties, and instructional advice ties in English language arts and mathematics. Unless referring to a particular category of work-related tie, we use the terms “work ties” and “ties” interchangeably. We concentrate on two issues. First, we examine the degree of dissolution of work-related ties among school staff over multiple school years. Some recent work (Daly & Finnigan, 2010; Finnigan, Daly, & Liou, 2016) suggests that there is considerable “churn” in the networks of district and school administrators, but this work does not examine churn in either the networks of other school leaders such as coaches and teacher leaders, or teachers’ networks. Second, we use social network methods to explore the predictors of tie dissolution at both the individual and organizational levels.

Our contributions are threefold. To begin, our work replicates and extends a small body of work that documents churn in work ties in school districts and schools (Bridwell-Mitchell & Cooc, 2016; Daly & Finnigan, 2010; Finnigan et al., 2016). Replication is essential if we are to amass an empirical body of knowledge to inform educational policy and practice (Makel & Plucker, 2014). Second, we extend prior work by attending to school leaders' and teachers' ties *and* by attending to all elementary schools in one local school district, rather than a handful of schools, as in prior work. Focusing on all schools and all professional staff within these schools extends prior work because school staff can move across schools within local school districts over time, and because it allows us to examine whether school-level factors within the same school system influence tie dissolution. Third, our article extends the empirical knowledge base by identifying factors associated with the breakup or dissolution of work ties. With the exception of one study (Bridwell-Mitchell & Cooc, 2016), most work to date, scarce as it is, has focused on the existence or formation of ties among school staff, rather than the dissolution of work ties.

We begin by motivating and situating our work with the empirical and theoretical literature on social capital. Next, we describe our methods involving social network analysis. Turning to findings, we examine the proportion of work ties among school staff that dissolve from year to year. We then present social network models that identify those factors associated with work tie dissolution and conclude by discussing our findings.

Anchoring and Framing the Work

We anchor and frame our work with research on social capital. Social capital refers to real or potential resources for action attained *through relations with others* (Bourdieu, 1986; Coleman, 1988; Lin, 1982, 2001). These resources can take several forms, such as goods and services, trust, and information (Coleman, 1988; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998), and both individuals and organizations can invest in, and benefit from, social capital (Ibarra, Kilduff, & Tsai, 2005). In the following sections, we anchor our work in the literature that shows how social capital enables school improvement in order to justify and motivate the focus of our analysis. We then frame our analysis using the empirical and theoretical literature on the dissolution of ties.

Returns to Social Capital

In schools, social capital is particularly important to the development of aspects of human capital such as individual knowledge and skills (Coleman,

1988; Loury, 1987). Schools are knowledge-intensive organizations, where staff must draw on their knowledge and skills to address a variety of complex issues, including the inherent complexities of teaching, variability in student needs, the uncertainty of student–teacher relations, and fundamental disagreements about the best approaches to the practice of teaching itself (Barr & Dreeben, 1983; Bidwell, 1965; Bidwell & Kasarda, 1987; Cohen, 1988; Meyer & Rowan, 1977). In knowledge-intensive organizations such as schools, the ongoing development of human capital is particularly important, and developing social capital is one important means to build such knowledge and skill (Frank et al., 2011; Zhao & Frank, 2003).

Ties among school staff are a necessary if insufficient condition for the development of social capital. These ties can facilitate access to resources such as advice and information, allowing the pooling of information that potentially enables knowledge development (Coburn, 2001; Daly & Finnigan, 2010; Frank et al., 2004; Frank et al., 2011; Kim, 2011; Spillane, 2004; Uzzi, 1997). Encountering new information, or combining different pieces of information, can lead to the development of new knowledge (Choo, 2002). Ties also push individuals to make their tacit knowledge explicit and thus more readily available to others (Eraut, 2000).

Various studies document the role of social capital in instructional reform and school improvement (Bryk & Schneider, 2002; Frank et al., 2004; Louis & Kruse, 1995; McLaughlin & Talbert, 2001; Rosenholtz, 1991; Smylie & Hart, 1999). Through their efforts to share expertise, discuss novel material, and share effective teaching strategies, teachers create learning opportunities for their peers (Brownell, Yeager, Rennells, & Riley, 1997; Davis, 2003; Little, 2003; Smylie, 1995). Ties to colleagues can also build teacher commitment and help develop a sense of belonging and efficacy (Grodsky & Gamoran, 2003).

Empirical research demonstrates that teachers learn about teaching through their interactions with their colleagues (Eraut & Hirsh, 2007; Frank et al., 2004). These interactions have also been shown to translate into increased student achievement: higher levels of teacher interaction are associated with higher student achievement in both mathematics and language arts, after controlling for school and individual factors (Goddard, Goddard, & Tschannen-Moran, 2007; Pil & Leana, 2009). Research using teacher value-added to measure teacher effectiveness also finds that teachers' peers explain a significant portion of their effectiveness, with teachers with more effective peers being more effective themselves (Jackson & Bruegmann, 2009). The development of social capital can, under the right circumstances, lead to improvements in human capital, which in turn have the potential to improve student outcomes. At the same time, it is important to acknowledge that social

capital, like any resource (e.g., human capital, material resources), can be used to not only enable improvement but also to inhibit it. Hence, ties among school staff also have potential drawbacks as well as benefits.

School leaders, particularly school principals, play an important role in assigning school staff to leadership positions, and to other positions within their schools; in turn, these assignments predict the work ties that can lead to the development of social capital (Spillane et al., 2012; Spillane et al., 2015). Principals, for example, often select specific teachers in their schools and assist in their promotion into the principalship (Lortie, 2009; Myung, Loeb, & Horng, 2011). Principals are more likely to select teachers with more prior leadership experience, but are also more likely to select teachers who are male and who share their race/ethnicity (Myung et al., 2011), suggesting that homophily may be a factor in the selection process. Other work similarly finds that some high school teachers that share the race of their principals are more likely to be assigned to supplemental responsibilities such as coaching (Grissom & Keiser, 2011). It is clear that school leaders, particularly school principals, make important decisions about assigning school staff to leadership positions, which in turn can predict the ties that can lead to the development of social capital (Spillane et al., 2012; Spillane et al., 2015).

But principals are not the only school leaders that matter when it comes to guiding instruction and enabling instructional improvement. Research on teacher leadership and research taking a distributed perspective to school leadership suggests that various “others,” including other administrators and teacher leaders, can also play important roles in leading and managing instructional improvement (Lord & Miller, 2000; Mangin & Stoelinga, 2008; Smylie & Denny, 1990; Spillane, 2006; York-Barr & Duke, 2004). Research suggests that these “other” school leaders often take on leadership functions and responsibilities that differ from those of the school principal (Camburn, Rowan, & Taylor, 2003; Spillane & Diamond, 2007; Spillane, Healey, & Kim, 2010). Furthermore, scholarship suggests that understanding how these different leadership positions work in interaction with one another is essential (Carlisle & Berebitsky, 2010; Printy, Marks, & Bowers, 2009; Matsumura, Sartoris, Bickel, & Garnier, 2009). Thus, it is important to pay attention not just to the principal but to school leaders more broadly defined, including other administrators and teacher leaders, who often combine part-time or even full-time teaching with leadership responsibilities.

The Dissolution of Ties

Prior literature provides mixed evidence on whether ties tend to persist or dissolve over time. Some work suggests that ties among people generally

persist rather than dissolve over time. Social network theory, for example, suggests thinking about ties not as discrete occurrences but as longitudinal events persisting across time (Snijders, Steglich, & Van de Bunt, 2010). Network scholars have theorized about friendship, trust, and cooperative ties, noting that such ties “can be regarded as *states* with a tendency to endure over time” (Snijders et al., 2010, p. 45, italics in original). Some empirical studies also document tie persistence over time. Research on collaborative teams in artistic and scientific fields, for example, suggests there is a high probability that these teams draw on past collaborators for new endeavors (Guimera, Uzzi, Spiro, & Amaral, 2005; Uzzi & Spiro, 2005). Similarly, two studies on schools and school systems suggest that ties persist over time. In one study, school district leaders reported they were more likely to share knowledge with those with whom they had previously interacted (Daly & Finnigan, 2010). In another study, school leaders’ and teachers’ prior instructional advice and information ties predicted the presence of subsequent ties between school staff (Spillane et al., 2012).

At the same time, there is evidence that ties tend to dissolve with time. Several longitudinal studies have documented significant “churn” in the network of both teachers and school and district administrators. A 2-year study of teachers’ networks in four elementary schools, for example, found that among teachers that formed a subgroup at time $t - 1$, a large proportion (between 24% and 53%) maintained no ties to any of those colleagues at time t (Bridwell-Mitchell & Cooc, 2016). Another longitudinal study, of the network connections across one school district, similarly found a high degree of tie breakup in the networks of school- and district-level administrators, driven largely by exits from the district (Finnigan et al., 2016). And another study found a large and significant decrease in ties between school and district administrators over time (Daly & Finnigan, 2010). Taken together, this work suggests that tie dissolution may be prominent, especially in schools and school districts.

The literature also offers some insights into why ties dissolve. Based on the importance of homophily in social tie formation, scholars have predicted that heterophilous relationships are more likely to dissolve, as different opinions would lead to conflict (Lazarsfeld & Merton, 1954), a finding that has been shown to be true particularly in regards to homophily of race (Bratter & King, 2008; Felmlee, Sprecher, & Bassin, 1990; Hallinan & Williams, 1987; Heaton, 2002). The larger structure of the network is also consequential for whether its ties persist or dissolve. Reciprocity tends to be associated with stability in ties, with reciprocal ties less likely to dissolve (Hallinan, 1978; Mollica et al., 2003; Rivera, Soderstrom, & Uzzi, 2010; Runger & Wasserman, 1980). Research on school districts also suggests that reciprocal relations among administrators are more likely to persist over time (Daly & Finnigan, 2010).

Another consequential aspect of network structure for tie persistence concerns whether or not members of a dyad share ties in common. Sharing common ties makes ties less likely to dissolve (Burt, 2000); in schools, the cohesion of teacher subgroups (as measured by the density of ties between them) predicts the maintenance of subgroup ties the following year (Bridwell-Mitchell & Cooc, 2016). The centrality of individuals in a social network also appears to matter with respect to tie dissolution, with individuals that are more *central* in a social network experiencing less tie dissolution (Saavedra, Reed-Tsochas, & Uzzi, 2008). In a study of school districts, district administrators who sought out more ties with others were also found to be more likely to receive ties over time (Daly & Finnigan, 2010). As described in the next section, our analysis controls for features of the network structure such as reciprocity and shared, or triadic, ties.

To examine the extent and predictors of tie dissolution, at least 2 years of data on the same networks are required, and more than 2 years of data is ideal, so that researchers can examine whether and to what extent dissolved ties reform in subsequent years. Our study uses four consecutive years of network data (2010-2013) from the same 14 elementary schools in a single school district. Our three research questions are the following:

Research Question 1: What is the extent of the dissolution (and re-formation) of work ties between school staff?

Research Question 2: What characteristics of individuals, dyads, and schools predict the dissolution of work ties?

Research Question 3: Are individual-level characteristics or aspects of the formal school organization more predictive of the dissolution of ties between school staff?

Research Methodology

Our analysis is based on data from a longitudinal study in a mid-sized Midwestern suburban school district we refer to as Auburn Park. Descriptive information on the 14 elementary schools in the district in 2012-2013 is presented in Table 1. Auburn Park enrolled approximately 5,900 students in 2012-2013 in 14 elementary schools. In 2012-2013, the student population was 82% White, 6% Latina/o, and 5% African American, and 25% of students received free or reduced-price lunches.

Data Sources

Our analysis is based on 4 years of data for all 14 elementary schools in Auburn Park. All elementary school teaching and administrative staff were

Table 1. Descriptive Statistics on Auburn Park Elementary Schools, 2013.

	<i>M</i>	<i>SD</i>	Min	Max
School size (membership)	418	92	250	601
% White students	82.23	7.79	66.85	92.31
% Black students	5.30	3.41	1.49	13.26
% Hispanic students	6.38	3.96	1.89	15.75
% Asian students	2.08	1.31	0.74	5.08
% Multiracial students	3.56	1.37	1.74	6.00
% FRPL students	24.90	17.32	5.46	59.39
% Mobile students	10.15	4.00	5.41	20.97
% ELL students	2.79	4.19	0.00	12.08
% Proficient on state reading test	86.86	4.00	80.00	92.00
% Proficient on state math test	82.21	5.60	71.00	92.00
# Teachers	31	5	20	39
% Teachers with advanced degree	57.80	14.52	34.48	80.77
% White teachers	98.26	2.45	93.77	100.00
% Black teachers	0.66	1.75	0.00	6.23
% Hispanic teachers	1.08	1.81	0.00	4.73

Note. FRPL = free or reduced price lunch; ELL = English Language Learner. *N* = 14.

sent a School Staff Questionnaire in the spring of 2010, 2011, 2012, and 2013. These surveys asked a variety of questions related to school culture, advice and information interactions, and respondents' backgrounds. High survey response rates—ideally as high as 70%—are required to effectively examine social networks (Kossinets, 2006; Wasserman & Faust, 1994); in 2010 through 2013, survey response rates in Auburn Park were 81% (*n* = 331), 95% (*n* = 393), 94% (*n* = 375), and 94% (*n* = 384), respectively. (Response rates for each year, by school and overall, are presented in Appendix A.)

The social network survey items were developed and validated in other studies (Pitts & Spillane, 2009; Pustejovsky & Spillane, 2009), and asked school staff to name their close colleagues, as well as the colleagues who they sought for advice and information in several curricular areas. Since these questions were asked separately, we analyze close colleague networks separately from instructional advice and information networks, although there is some overlap between them. To elicit school staff's close colleague networks, our survey asked, "Who are your closest colleagues in your school?" and allowed school staff to list up to 12 individuals. To elicit school staff's instructional advice and information ties, the survey asked, "During this

school year, to whom have you turned to for advice and/or information about curriculum, teaching, and student learning?” also allowing survey respondents to list up to 12 individuals. For instructional advice and information questions, the names supplied by school staff were autopopulated in a follow-up question that asked respondents to indicate the specific content area for which they sought advice and/or information from each person, including reading/English language arts (which we refer to as “language arts”) and mathematics, the two content areas focused on in our analyses.¹

Quantitative Measures and Analysis

Tie dissolution and persistence. The dependent variable for our analyses was an indicator for tie dissolution since the prior year. Specifically, the dependent variable Y_{ijk} indicated whether a tie directed from school staff member i to school staff member j in school k dissolved between year $t - 1$ and year t . This variable was defined as follows:

$$Y_{ijk} = \begin{cases} 1 & \text{if there was a tie from } i \text{ to } j \text{ in year } t - 1 \text{ but not in year } t \\ 0 & \text{otherwise} \end{cases}$$

Since our network data spanned the years from 2010 to 2013, we constructed measures of tie dissolution between three pairs of years (2010 and 2011, 2011 and 2012, and 2012 and 2013). Ties assigned a 0 were those where either no tie existed in both year $t - 1$ and year t , those where a tie existed in both years, or where there was no tie in year $t - 1$ and a tie in year t .

Ties that dissolved between year $t - 1$ and year t could have dissolved for several reasons. One reason was because a school staff member no longer saw the individual as a close colleague, or chose to no longer seek out that individual for advice or information about teaching. However, ties between school staff could also have dissolved because one member of the dyad left our survey sample; in that case, that tie would appear to have dissolved in year t simply because one or both members of the dyad had left the sample. A significant amount of the tie dissolution we observed in our data was due to such exits from the sample: In 2011, for example, 18% of the prior year’s close colleague ties were not observed the following year because at least one member of the dyad left the sample (19% and 20% of math and language arts ties, respectively, dissolved for the same reason). Given our high survey response rates, most exits from our sample were likely to have been exits from the district.

We addressed this issue in our analyses in two ways. First, we conducted our descriptive analyses both including and excluding school staff that left

the district; this allowed us to examine the extent to which tie dissolution was driven by such exits. For our network analyses we took another approach, limiting our sample to school staff that were observed in the district in both year $t - 1$ and year t . Limiting our analyses to ties between those observed at both time points enabled us to focus our analyses on the predictors of tie dissolution among those that remained in the district in consecutive years, and prevented us from conflating tie dissolution due to exits from the district with tie dissolution due to other factors.

Independent variables. Because of the lack of prior work on tie dissolution among school staff, we included in several covariates our network models that have been shown to predict the *presence* of an advice or information tie between school staff members (Moolenaar et al., 2014; Spillane et al., 2012; Spillane, Shirrell, & Hopkins, 2016). Following prior work that finds that schools' formal organizational structures more strongly predict the presence of ties than do individual characteristics (Spillane et al., 2012), we divided our covariates into those that focused on either the formal organizational structure or individual-level characteristics. At the individual level, these covariates were as follows:

- *First year in school.* Social integration is a key aspect of socialization into a new organization (Morrison, 1993), and organizational newcomers—including teachers—actively engage in advice seeking in an attempt to learn about their work (Adkins, 1995; Morrison, 1993; Kardos & Johnson, 2007; Ostroff & Kozlowski, 1992). Since staff new to a school may have engaged in a period of “search” as they attempted to locate reliable sources of advice and information, we included an indicator for being new to the school in year $t - 1$ in our models. Although a significant number of staff were new to their schools each year, these staff members were generally new to the district, as opposed to changing schools within the district. Since very few Auburn Park school staff members changed schools within the district during the time of our study,² we did not include an indicator for changing schools within the district in our analyses.
- *School commitment.* Organizational theory suggests that knowledge-intensive organizations such as schools, where staff are called on to address dynamic challenges using uncertain technologies, are best suited to more “organic” organizational forms, which rely on staff's engagement and commitment instead of bureaucratic controls (Bryk et al., 2010; Miller & Rowan, 2006; Rowan, 1990). This form of management is characterized by teacher involvement in school decision

making, and thrives when there is cooperation, commitment, and collegiality among school staff (Miller & Rowan, 2006). Since school staff that exhibited higher levels of commitment to their schools may have been less likely to dissolve their ties than other staff, we included a measure of school commitment in our analyses. To measure school commitment, we created a factor using four survey items that asked school staff about their commitment to their schools, and asked staff to rate their agreement on a five point Likert-type scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*; see Appendix B for specific items and descriptive statistics on this factor for 2013 [other years were similar]). This factor measure was standardized across the entire sample each year and included in our network models as a covariate. In some models, we included measures of the difference in school commitment between members of dyads, while in other models we included an indicator for whether a staff member experienced a negative change in school commitment between year $t - 1$ and year t .

- *Perceptions of school leadership.* A variety of aspects of school working conditions, including opportunities for collaboration, expanded roles within schools, and professional development, are all manifestations of school leadership, at least in part (Ladd, 2011). Given the importance of school leadership to many aspects of schools, as well as the fact that perceptions of school leadership predict teachers' plans to leave their schools (Ladd, 2011), we included a measure of perceptions of school leadership in our analyses. To measure perceptions of school leadership, we created a factor using 11 survey items that asked school staff about the frequency with which their school principal and other school leaders (e.g., assistant principal, coach) engaged in a variety of practices, each of which was rated on a five point Likert-type scale ranging from 1 (*never*) to 5 (*always*; see Appendix B for specific items and descriptive statistics). For teachers, these questions asked about their school principal and other school leaders; for principals, these questions asked about leaders other than themselves in the school.
- *Beliefs about teaching mathematics.* Across the time of our study, Auburn Park changed the way mathematics was taught in elementary schools, moving from a procedural to a more conceptual approach (Spillane, Hopkins, & Sweet, 2017). Structures for professional collaboration, particularly around mathematics, also underwent a significant change (Spillane et al., 2016). Recent work in Auburn Park finds that changes in exposure to others' beliefs about mathematics predicts changes in teachers' own beliefs about mathematics, with those who

are exposed to more reform-oriented math beliefs becoming more reform-oriented in their own beliefs over time (Spillane et al., 2017). We used six survey items about math beliefs, each of which was rated on a five point Likert-type scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), to create a measure of reform-oriented math beliefs identical to that used in Spillane et al. (2017; see Appendix B for specific items used and descriptive statistics on this factor in 2013). We then created an indicator for school staff whose math beliefs were more than a standard deviation below the mean for the entire sample in each year, and included this indicator in our models as a covariate; this indicator for having “low” math beliefs can be thought of as indicating school staff with more traditional (i.e., nonreform-oriented) math beliefs. In other models, we included a measure of the difference in math beliefs between members of a dyad, while in other models, we included measures of negative change in math beliefs (i.e., a change toward more traditional, less reform-oriented math beliefs) between year $t - 1$ and year t .³

At the formal organizational level, covariates were as follows:

- *Taught multiple grades.* Teaching multiple grades in elementary schools is associated with the presence of instructional ties between school staff, with multiple grades teachers generally less likely to be sought out for or seek advice (Spillane et al., 2012). To determine whether teaching multiple grades similarly predicted the dissolution of ties, we included in our models an indicator for whether teachers reported teaching multiple grades in year $t - 1$. This variable was assigned a value of zero for principals and administrators who did not hold classroom teaching responsibilities.
- *Lost leadership position.* Prior work finds that school staff that hold leadership positions are more likely to be sought out for advice than other school staff (Spillane et al., 2012). To test whether the loss of such a leadership position predicted tie dissolution, we included an indicator for the loss of a leadership position since year $t - 1$ in our models. This variable was assigned a value of 1 if a respondent held a leadership position (principal, assistant principal, coach, mentor, grade-level leader, or master teacher) in year $t - 1$, and did not hold such a position in year t , and 0 otherwise.
- *No longer same grade level.* Prior work finds that teaching the same grade level significantly and strongly predicts the presence of instructional ties between school staff (Spillane et al., 2012). Although

teaching the same grade level is associated with the presence of a tie, it is unclear whether these ties persist when one member of the dyad leaves that grade level. To investigate this question, we included a dyad-level covariate indicating whether a dyad taught the same grade level in year $t - 1$ but did not in year t . This variable was assigned a value of zero for dyads that included at least one member that was not listed as having any classroom teaching responsibilities, such as principals and other administrators.

- *Network size.* We also included network size as a covariate in our models, since network size is generally associated with the likelihood of ties between members of a network (Wasserman & Faust, 1994).

Each individual-level covariate was included for both tie senders and receivers; descriptive information on the covariates for each year of our analysis is presented in Table 2. The table displays information on school staff that were observed in both year $t - 1$ and year t for each year of our study. Since school staff in Auburn Park elementary schools were overwhelmingly White (99% in 2013) and female (90% in 2013), we did not include race and gender as covariates in our models.

Modeling approach. To explore the predictors of the dissolution of work ties, we used hierarchical latent space models (HLSMs; Sweet, Thomas, & Junker, 2013). As in other social network methods, HLSMs categorize those in the network (commonly referred to as “nodes”) as either “senders” or “receivers,” depending on whether the individual is the one seeking or being sought out. HLSMs estimate the likelihood of a tie between actors in a network based on covariates at the sender, receiver, dyad, and network levels, as well as nodes’ positions in a latent space (Sweet et al., 2013).⁴ We chose HLSMs to examine tie dissolution because while most social network methods are limited to the analysis of a single network at a time, HLSMs can draw on information from numerous independent networks to estimate overall effects, and allow the inclusion of a variety of covariates at the node, dyad, and network levels (Sweet et al., 2013).

Another advantage of HLSMs is that through the inclusion of latent space positions, the models control for structural aspects of networks such as reciprocity, centrality, and shared ties (Sweet et al., 2013). Thus, in our social network analyses, we were not required to explicitly model triadic ties and reciprocity, as our models already accounted for these structural characteristics. However, we conducted several descriptive analyses to examine differences in tie dissolution between pairs that differed on these characteristics, which we describe below.

Table 2. Descriptive Statistics on Covariates for Colleague, Math, and Language Arts Networks, Auburn Park, 2010-2011, 2011-2012, and 2012-2013.

	2010-2011	2011-2012	2012-2013
Individual			
First year in school	0.18 (0.39)	0.12 (0.33)	0.11 (0.32)
School commitment	0.04 (0.98)	0.03 (1.00)	0.01 (0.99)
Perceptions of school leadership	0.03 (1.00)	0.01 (0.99)	-0.02 (0.99)
Low math beliefs	0.13 (0.33)	0.13 (0.34)	0.16 (0.37)
Formal organization			
Multiple grades	0.31 (0.46)	0.30 (0.46)	0.27 (0.44)
Lost leadership position	0.08 (0.26)	0.07 (0.26)	0.06 (0.23)
Nodes, <i>n</i>	268	297	303
Dyad			
No longer same grade level	0.07 (0.26)	0.08 (0.27)	0.06 (0.24)
Colleague tie dissolved since prior year	0.07 (0.25)	0.06 (0.24)	0.05 (0.22)
Math tie dissolved since prior year	0.03 (0.18)	0.03 (0.18)	0.04 (0.19)
Language arts tie dissolved since prior year	0.06 (0.23)	0.04 (0.20)	0.05 (0.22)
Dyads, <i>n</i>	5,374	6,426	6,598
Network			
Network size	19 (6.3)	21 (5.7)	22 (5.1)
Networks, <i>n</i>	14	14	14

Note. Standard deviations in parentheses. All covariates are measured in year $t - 1$ with the exception of lost leadership position and no longer same grade level, which compare year $t - 1$ and year t . Statistics are computed on the sample of individuals that are observed in both year $t - 1$ and year t .

One requirement of HLSMs is that nodes be assigned to a single network and not be cross-listed in multiple networks. Since relatively few school staff were cited in multiple schools' networks, we assigned nodes that appeared in multiple schools' networks to the school where they were cited most often as advice givers. Since HLSMs allow for the cross-sectional analysis of network data, we analyzed each year's networks separately.

In our HLSMs, the dependent variable Y_{ijk} indicated the dissolution of a previously existing tie between staff member i and staff member j in school k , as explained above. We implemented our HLSMs as follows:

$$\log \frac{P(Y_{ijk} = 1)}{1 - P(Y_{ijk} = 1)} = \beta_0 + \beta_1 X_{1ijk} + \dots + \beta_8 X_{8ijk} - |Z_{ik} - Z_{jk}|$$

Here, the X_{ijk} are the node-, edge-, or network-level covariates described above, and Z_{ik} and Z_{jk} are the latent space positions for staff members i and j . Some analyses included only the individual-level covariates outlined above, while other analyses included both individual-level and formal organizational covariates in the models.

Modeling the factors associated with network change between two time points requires that the network be measured at appropriately spaced points in time. If the networks are measured at two time points that are too close together, insufficient change will be observed between time points, making it difficult to estimate effects; if the time points are too far apart, too much change will be observed between them, calling into question the assumption that the observations capture gradual change in the network (Snijders et al., 2010). A quantitative measure of the degree of change between two time points is the “Jaccard index,” which measures the proportion of ties that remain from one time point to the next, relative to the complete number of ties (Snijders et al., 2010). Values of the Jaccard index over 0.3 are preferable, and values below 0.2 suggest that the change process may be too rapid to be captured by the given observations of the network (Snijders et al., 2010). For our networks, Jaccard indices ranged from 0.34 to 0.50, suggesting that our yearly observations of the networks were appropriately spaced to capture changes in ties between school staff.

Findings

We organize our results as follows: First, we describe the dissolution of ties among school staff in Auburn Park over 4 years (2010-2013). Specifically, we examine tie dissolution in three social networks: close colleague networks, mathematics instructional advice and information networks, and language arts instructional advice and information networks. Overall, our analysis suggests that large percentages of school leaders’ and teachers’ ties dissolve from year to year, and that most of these ties do not subsequently re-form. Second, we model those factors associated with the dissolution of a tie between two school staff members. This analysis shows that the formal organizational structure, in terms of changes in the grades teachers are assigned to teach and changes in their formal leadership positions, are especially important when it comes to the dissolution of work ties between school staff.

Table 3. Percentage of Ties Dissolved Between Years, Auburn Park, 2011 to 2013.

	2010 to 2011	2011 to 2012	2012 to 2013
Panel A: Including district exits			
Colleague ties	0.56 ($n = 1,693$)	0.58 ($n = 2,013$)	0.56 ($n = 1,826$)
Mathematics ties	0.65 ($n = 658$)	0.65 ($n = 857$)	0.65 ($n = 894$)
Language arts ties	0.65 ($n = 1,269$)	0.64 ($n = 1,413$)	0.63 ($n = 1,348$)
Panel B: Excluding district exits			
Colleague ties	0.46 ($n = 1,391$)	0.47 ($n = 1,603$)	0.47 ($n = 1,520$)
Mathematics ties	0.56 ($n = 530$)	0.54 ($n = 657$)	0.59 ($n = 755$)
Language arts ties	0.56 ($n = 1,009$)	0.54 ($n = 1,105$)	0.54 ($n = 1,145$)

Note. Panel A shows overall percentage of ties dissolved; Panel B limits to those that were observed in data in year $t - 1$ and year t . n = number of total ties in base year (Panel A), or number of total ties between school staff that were observed in district in consecutive years (Panel B). Networks are not limited to survey respondents.

Dissolution of the Work-Related Social Ties of School Staff

Looking across all three networks—close colleague, mathematics, and language arts—our analysis suggests that there is considerable instability in school staff members' work-related ties. The top panel of Table 3 shows the percentage of year $t - 1$ ties that dissolved in year t , for all three types of networks (close colleague, mathematics, and language arts) in all three pairs of years (2010 to 2011, 2011 to 2012, and 2012 to 2013). In each pair of years, roughly 65% of mathematics and language arts ties in year $t - 1$ dissolved in the following year; in other words, only 35% of mathematics and language arts instructional ties persisted to the following year, close colleague ties were more persistent, but more than half (56% to 58%) of these ties in year $t - 1$ dissolved in the following year. These findings were consistent across the 3 years.

To determine how much of this tie dissolution was driven by exits from the district, the bottom panel of Table 3 displays the same measures as the top panel, only this time limiting the sample to school staff that we observed in the district in both year $t - 1$ and year t . These statistics thus quantify the extent of tie dissolution between individuals that remained in the district in consecutive years. After excluding district exits from the sample, we still found a high degree of dissolution in work ties. As can be seen in the bottom panel of Table 3, more than half (54% to 59%) of instructional ties in both mathematics and language arts dissolved the following year, even after removing ties that dissolved due to exits from the district. Close colleague ties showed more persistence, but more than 45% of these ties dissolved the following year, even after limiting to those that remained in the district.

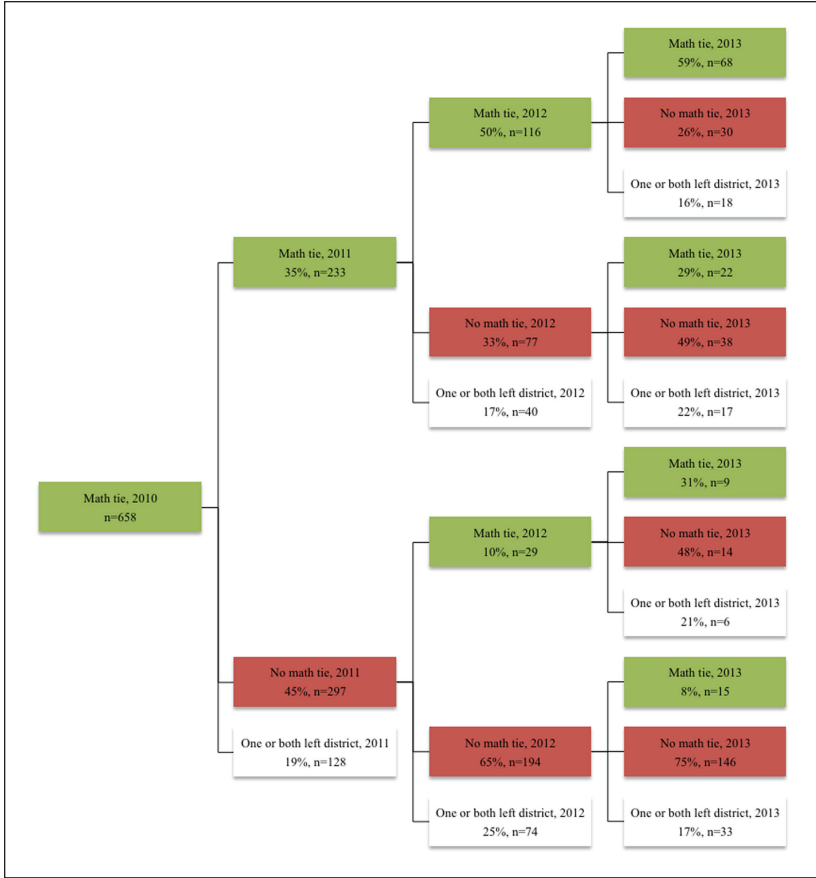


Figure 1. Persistence and dissolution of math instructional advice and information ties, Auburn Park, 2010 to 2013.

Even though we find significant year-to-year instability in school staff’s work ties, ties that dissolved in year t could have reemerged in year $t + 1$, or even year $t + 2$ or $t + 3$. To examine whether this was the case, we plotted the dissolution and reemergence of work ties across the 4 years of our data. The plot for mathematics ties is displayed in Figure 1 (we found similar patterns for close colleague ties and instructional ties in language arts). This figure—which includes ties that dissolved because of exits from the district—shows that the majority of ties that dissolved did not reappear in subsequent years; instead, ties that dissolve generally remained dissolved. Of the 2010 mathematics ties that

dissolved in 2011, for example, 65% of those ties remained dissolved in 2012, while only 10% reemerged (the remaining 25% remained dissolved because one or both members of the dyad left the district).

One question concerns whether tie dissolution varied across schools. To determine the extent of variation in tie dissolution across schools, we ran a series of multilevel models on our dyad-level data for each type of network in each pair of years, with tie dissolution since the prior year as the outcome, no covariates, and a random effect for schools. Results from these models demonstrated that there was very little variance in tie dissolution at the school level. Intraclass correlations for these analyses ranged from nearly zero (0.006) to 0.07, suggesting that schools accounted for a very small proportion of the variance in tie dissolution in Auburn Park. Instead, within-school variation explained almost all of the variation in tie dissolution we observed.⁵

In separate descriptive analyses, we examined whether reciprocal ties, as well as ties that were part of triads, dissolved more or less frequently than other ties. In close colleague and language arts networks, pairs that were part of a triad (i.e., that shared at least one common alter in year $t - 1$) did not dissolve at different rates than pairs that were not part of triads. In two of the three pairs of years we examined, math ties were less likely to dissolve when the pair was part of a triad in year $t - 1$. In terms of reciprocal ties, we found that ties where both members of the dyad cited one another as close colleagues or instructional advisors were much less likely to dissolve than non-reciprocal ties; this was true for all three types of ties. Since these structural aspects of networks are controlled for by the latent space positions included in our models (Sweet et al., 2013), we did not explicitly include these structural measures in our network models.

Modeling Tie Dissolution in School Staff Instructional Networks

Our first HLSM models estimated the effects of individual-level covariates (first year in school, school commitment, perceptions of school leadership, and low math beliefs) on tie dissolution, omitting covariates that measured the formal school organization from the models. We found no consistent patterns of effects across the years for any individual-level covariates when we estimated impacts on tie dissolution in close colleague, mathematics, or language arts networks. Finding no consistent effects of individual-level covariates on tie dissolution, we next estimated HLSM models that included both individual- and formal organization-level covariates at the node, dyad, and network levels; we report parameter estimates from our models predicting the dissolution of math ties in Table 4, and discuss results for close colleague ties and language arts ties in the few cases when they differed qualitatively

Table 4. Predictors of Tie Dissolution in Math Advice and Information Networks, Auburn Park, 2010 to 2013.

	2010 to 2011 Estimate	2011 to 2012 Estimate	2012 to 2013 Estimate
Sender			
Multiple grades	-0.888	-0.989	-0.514
First year in school	0.210	0.523	0.278
School commitment	-0.018	-0.083	0.145
Perceptions of school leadership	0.232	0.023	0.200
Low math beliefs	-0.130	0.186	0.509
Lost leadership position	-0.085	0.355	0.186
Receiver			
Multiple grades	0.127	-0.376	-0.061
First year in school	-0.095	-0.045	-0.426
School commitment	0.107	-0.015	0.038
Perceptions of school leadership	-0.014	-0.057	0.079
Low math beliefs	-0.281	-0.048	0.498
Lost leadership position	0.258	0.901	0.645
Dyad			
No longer same grade level	2.202	2.911	2.618
Network			
Network size	-0.037	-0.028	-0.059

Note. Each column reports results from a hierarchical latent space model where the sample was limited to school staff that were observed in the district in both years. Bold estimates are those for which the 95% credible interval for the estimate does not overlap zero.

from our mathematics estimates. Estimates in the table are shown in bold if the quantiles from the distributions of the estimation samples between 2.5 and 97.5 (the Bayesian analog to a frequentist 95% confidence interval) do not include zero. These estimates—shown in bold in the table—can be considered statistically significant at the 5% level.

Results from Table 4 show that the main factors associated with the dissolution of a tie between two staff members pertain to the formal school organizational infrastructure; individual-level characteristics generally do not significantly predict the dissolution of work ties. This was true for close mathematics, close colleague, and language arts networks. Specifically, changes in staff members' positioning within the formal organizational infrastructure of their schools were strongly associated with tie dissolution. The

strongest predictor of tie dissolution in all three networks was no longer teaching the same grade. This meant that if two staff members taught the same grade level in year $t - 1$ but not in year t , the close colleague, mathematics, or language arts tie between them was significantly more likely to dissolve than a tie between other pairs. Contrary to the speculation in prior work (Spillane et al., 2012), this implies that work ties generally do not persist when school staff's grade-level assignments change. Instead, ties are much more likely to dissolve when school staff change grades.

To give a sense of the magnitude of these findings, we ran simple descriptive statistics to compare tie dissolution between dyads that taught the same grade level in year $t - 1$ but not in year t and all other dyads, limiting these analyses to dyads that had a tie in year $t - 1$. Between 2012 and 2013, 82% of mathematics ties between dyads that worked in the same grade level in 2012 but did not in 2013 dissolved (89 ties out of 109). In contrast, only 42% of other pairs' close colleague ties dissolved (150 of 359). The dissolution of language arts ties showed a similar pattern. In close colleague networks, between 2012 and 2013, 57% of ties between those that no longer taught the same grade level dissolved (82 of 143), compared with 31% (260 of 847) for all other pairs. Along with the results from our network models examining close colleague ties, this suggests that changes in grade level were less predictive of tie dissolution in close colleague networks than in instructional advice networks in either math or language arts.

Moving out of a formal leadership position was also associated with the breakup of a social tie in all three types of networks. Specifically, when the tie receiver (the school staff member being sought out for advice) held a leadership position in year $t - 1$ but lost that position in year t , that staff member's ties were significantly more likely to dissolve than other staff's ties. This effect was statistically significant in two of the three years we examined for both mathematics and language arts ties, with a relatively large (although statistically insignificant) effect in the other year. Interestingly, however, the tie receiver losing a leadership position was less predictive of the breakup of close colleague ties than of instructional ties. In two of the three pairs of years, the receiver effect of losing a leadership position was small and statistically insignificant for close colleague ties. This again suggests that aspects of the formal organizational infrastructure—in this case, losing a formally designated leadership position—matter to tie dissolution, but they matter more for advice seeking around instruction than they do to close colleague ties.

In contrast to the importance of changes in the formal organizational infrastructure to tie dissolution, we find that individual-level characteristics such as school staff's commitment to their school, perceptions of the effectiveness of their school's leadership, and their beliefs about instruction generally do

not predict the breakup of their work ties. Across all three pairs of years we analyzed and across all three types of networks, school commitment, perceptions of school leadership, and having more traditional math beliefs did not predict tie dissolution. In analyses not reported here, we also examined whether large differences in these individual-level measures (greater than two standard deviations) between members of a dyad at time $t - 1$ predicted the breakup of that dyad at time t , and found no consistent associations between such large differences and the dissolution of ties. We also explored whether negative changes in school commitment, perceptions of school leadership, or math beliefs between time $t - 1$ and time t predicted tie dissolution; again, we found no patterns of significant associations between negative changes in these individual-level measures and the dissolution of ties. The exception was 2012, where a negative change in school commitment since the prior year for tie receivers was associated with an increased likelihood of tie dissolution in all three types of networks.

The remainder of the individual-level covariate effects were inconsistent across years and type of network. For example, there was some evidence that the tie sender being new to the school in year $t - 1$ predicted tie dissolution, but only in mathematics networks. One exception was teaching multiple grades, where the tie sender teaching multiple grades was generally a negative predictor of tie dissolution. This suggests that the work ties of multiple grades teachers were less likely to dissolve than those of other school staff. Overall, however, the inconsistency of these effects again emphasizes the importance of the formal organizational infrastructure—particularly changes in that infrastructure—to predicting the breakup of ties between school staff.

Discussion and Conclusion

Our analysis makes three contributions with respect to the dissolution of work ties in schools and school systems. First, we build on prior work to document considerable instability in interactions among school staff from one school year to the next. We show that this instability is consistent across close colleague as well as instructional advice and information networks for mathematics and language arts. Furthermore, we show that these ties are not just temporarily lost, but generally remain dissolved, at least for the 3-year timeframe of our study. Second, we not only replicate the few prior studies on churn in work-related ties in educational organizations but also extend them by attending to all elementary schools in one district, allowing us to discriminate between churn related to exiting the school system from simply shifting schools with the system. We also examine the ties of teachers and school leaders, a significant extension of prior work. Finally, our analysis documents

those factors associated with the breakup or dissolution of work ties among school staff. Specifically, we find that aspects of the formal organizational infrastructure (e.g., changing grade level or losing a leadership position) are more strongly associated with the breakup of a social tie among school staff than individual-level factors such as school commitment, perceptions of school leadership, or beliefs about instruction.

Our findings are both consistent and inconsistent with prior work on the dissolution of ties. The extensive breakup of work ties we find over school years is consistent with prior work on teachers' ties, as well as those of district and school administrators, where the existing research has documented considerable churn in these work networks over time (Bridwell-Mitchell & Cooc, 2016; Daly & Finnigan, 2010; Finnigan et al., 2016). Similar to this work, we find high levels of churn in the work ties of school staff. At the same time, our findings on the prevalence of tie dissolution among teachers are inconsistent with other empirical work on social networks, which suggests that ties tend to persist rather than dissipate over time. As noted earlier, friendship, trust, and cooperative ties have been theorized as states that "endure over time" (Snijders et al., 2010, p. 45), and the persistence of ties has been empirically documented in several fields (Guimera et al., 2005; Uzzi & Spiro, 2005).

Our work also contradicts prior work that suggests that individual- and dyad-level factors—particularly "homophily"—strongly predict the persistence of ties (Bratter & King, 2008; Felmler et al., 1990; Hallinan & Williams, 1987; Heaton, 2002). It is important to note, however, that much of the prior work on these individual- and dyad-level predictors of ties focused on race, gender, and education, while our individual- and dyad-level measures explore work-related attitudes such as school commitment, views of the effectiveness of school leadership, and beliefs about instruction. Because our sample is almost entirely White and female, we are unable to explore the associations between racial and gender homophily on tie dissolution, an area for future research.

In a district with more diversity in terms of the race and gender of school staff, it is possible that aspects of race and gender could be associated with tie dissolution. However, there are several reasons that this might not be the case. First, our analyses find that few if any individual characteristics predict tie dissolution. Second, although some prior work has found a significant associations between gender and race homophily and the likelihood of work-related ties (e.g., Spillane et al., 2012), effect sizes in these studies are generally small, especially compared with aspects of the formal organizational infrastructure such as grade-level assignment. Hence, it is not entirely clear that the results found here would be different in a more diverse setting, though this is of course an empirical question that remains to be answered.

While the breakup of ties between teachers that change grade levels may not be surprising, the dissolution of cross-grade ties poses major challenges for schools. The vertical alignment of a school's instructional program across grades depends in some measure on teachers in different grades maintaining ties about instruction, especially in core school subjects such as mathematics and language arts (Bidwell, 1965). If the breakup of work-related ties is largely a function of teachers moving to different grades, this does not bode well for the vertical alignment of the elementary school curriculum, and may partially account for why the content that students are exposed to from one grade to the next tends to repeat rather than build on prior years (Polikoff, 2012). In addition, the dissolution of social ties that accompanies grade changing may explain why switching grades is associated with school-level teacher turnover (Blazar, 2015; Ost & Schiman, 2015) and lower teacher performance (Blazar, 2015). Our findings raise the possibility that some of the negative effects of grade switching may be due to the disruption of work ties that often accompany a change in grade.

By identifying those factors associated with the dissolution of work ties among school staff, however, we offer insights into the particular circumstances that may drive our results. Distinct from much prior work on the dissolution of ties (which has often focused on romantic or friendship ties), our analysis focuses on work-related ties that form (and dissolve) within organizations. These organizations impose a variety of organizational structures on teachers' work, including assigning positions and membership in particular teams. Not only are the ties we study part of particular schools, but these schools are nested in a larger system of organizations at the local school system level. One explanation for our findings, therefore, is that these formal organizational arrangements in some sense mitigate the importance of individual- and dyad-level factors when it comes to the breakup of the work-related ties of school staff. In a broader sense, then, our findings speak to the critical role of the formal school and school system organizational infrastructure not only in the formation of ties about work but also in their dissolution.

School leaders (e.g., administrators, specialists, and teacher leaders) play important roles in shaping teachers' opportunities to develop ties and, by extension, potentially social capital. One way that school administrators (particularly principals) shape opportunities to develop social capital is by assigning staff to grade levels and leadership positions (Bryk et al., 2010; Kruse et al., 1995). Our findings therefore have several implications for leadership practice, particularly as it relates to the assignment of staff to grade levels and leadership positions. One implication is that school administrators (particularly principals) should be thoughtful in deciding to change teachers'

assignments to grade levels and leadership positions, as changes in these assignments can have significant effects on their teachers' social ties.

As noted earlier, social ties can enable the development of social capital, which in turn can enable or even inhibit improvement. Like any resource, social capital can be mobilized for different ends. Hence, tie dissolution in and of itself is neither inherently a negative nor a positive, but the specific impacts may instead depend on the circumstances. When teachers change grade levels and their prior ties dissolve, they may lose opportunities to develop social capital through their ties with their former grade-level colleagues. Insofar as school leaders hope to build cross-grade communication and collaboration, such tie dissolution will be a negative. However, it is possible that school leaders at times move teachers between grade levels in an effort to disrupt established patterns of ties among school staff, in the hopes of spurring new interactions (or constraining existing ones). In such circumstances, tie dissolution could be viewed more positively. Whether tie dissolution is viewed as negative or positive, school leaders should attend to the potential impacts of the movement of teachers across grade levels—as well as out of leadership positions—on school staff ties, as those movements can have important implications for the development of social ties and by extension social capital within schools. This is particularly important considering that the literature, reviewed earlier, points to the potency of social ties for innovation. Future work might explore school leaders' decision making about moving teachers across grades and leadership positions and its relations to social capital development.

It is somewhat ironic that our finding that the formal infrastructure matters to the dissolution of work ties emerges from a context (U.S. public schools) where the formal organizational infrastructure has long been thought to be decoupled from schools' core instructional work—instruction (Meyer & Rowan, 1977; Orton & Weick, 1990; Weick, 1976). Our finding on the importance of the formal infrastructure to school staff work ties may reflect efforts by local school systems over recent decades to recouple formal structure and instruction through the design and redesign of educational infrastructure (Coburn, 2004; Hallett, 2010; Spillane et al., 2011). More broadly, however, it points to the need for researchers studying the breakup of work ties to pay much more attention to not only the individual- and dyad-level predictors of tie dissolution, but also to the influence of the organizational arrangements within which such ties are nested (Small, 2009; Spillane et al., 2012). Work ties do not occur in a vacuum, but rather within a more or less formal organizational and system infrastructure. Our analysis suggests that these organizational and system arrangements are, at least in education, a great deal more important than individual- and dyad-level characteristics in determining the breakup of ties about work.

Appendix A

Auburn Park Survey Response Rates, 2010 to 2013.

School ID	2010	2011	2012	2013
1	0.85	0.95	0.89	0.90
2	1.00	0.96	0.96	0.93
3	0.86	0.95	0.84	0.97
5	0.89	0.97	0.94	0.90
4	0.82	1.00	0.73	0.96
6	0.77	0.96	0.78	0.87
7	0.78	0.93	0.90	0.97
8	0.88	1.00	1.00	1.00
9	0.83	0.94	0.94	0.91
10	0.89	0.94	0.97	0.92
11	0.97	0.94	0.87	0.97
12	0.39	0.94	0.90	0.97
13	0.26	0.93	0.90	0.93
14	0.80	0.94	0.94	0.91
Overall	0.78	0.95	0.91	0.94

Appendix B

Descriptive Information on Factor Measures, Auburn Park, 2013.

Factor	Survey Items	Loading	Eigenvalue	Alpha
School Commitment	I usually look forward to each working day at this school.	0.72	2.33	0.85
	I wouldn't want to work in any other school.	0.74		
	I feel loyal to this school.	0.85		
	I would recommend this school to parents seeking a place for their child.	0.74		
Perceptions of School Leadership	My principal [Other leaders at my school] . . . Demonstrate[s] high expectations for all students.	0.75	7.55	0.96
	Use[s] data to inform decision making.	0.64		
	Work[s] with individual teachers effectively to improve instruction.	0.86		

(continued)

Appendix B (continued)

Factor	Survey Items	Loading	Eigenvalue	Alpha
	Cultivate[s] a shared vision and common purpose among staff.	0.86		
	Encourage[s] teachers to be learners.	0.88		
	Create[s] opportunities for teachers' learning.	0.88		
	Promote[s] improvement of student outcomes.	0.82		
	Support[s] the development of adult learning communities.	0.82		
	Work[s] effectively to develop parent involvement in the school.	0.86		
	Encourage[s] teachers to be leaders.	0.87		
	Works effectively to develop community involvement in the school.	0.84		
Math Beliefs	Recall of number facts should precede the development of an understanding of the related operation.	0.72	3.19	0.87
	Students should master computational procedures before they are expected to understand how those procedures work.	0.82		
	Time should be spent practicing computational procedures before students are expected to understand the procedures.	0.69		
	Students should not solve simple word problems until they have mastered some number facts.	0.72		
	Time should be spent practicing computational procedures before students spend much time solving problems.	0.75		
	Students will not understand an operation until they have mastered some of the relevant number facts.	0.67		

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Notes

1. Survey respondents were not limited to naming advisors in their school or even in the district; for this reason, some named as close colleagues or colleagues sought out for advice were not survey respondents themselves. For our descriptive analyses of tie dissolution and persistence, we included ties that were directed at individuals that were not respondents to our surveys; however, we limited our social network analyses to survey respondents for whom we had data in both year $t - 1$ and year t , due to the requirements of our modeling approach, which is outlined below.
2. Out of the 899 times in our data where we observed a staff member in consecutive years, only 24 times (3%) did a staff member change schools within the district.
3. We imputed school means for our math beliefs factor for school staff that did not respond to the relevant survey questions. We imputed values for this factor for 58 school staff in 2010-2011 and 2012-2013, and for 60 school staff in 2011-2012. Since results did not differ when we excluded these imputed cases, the results reported here are those that include them.
4. These latent space positions can be thought of as akin to residuals in a regression model. A detailed discussion of HLSM models is beyond the scope of this article; see Sweet et al. (2013) for further detail.

5. In addition, very little (9%) of the variance in our covariates was explained at the between school level.

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