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A Cognitive Perspective on Policy Implementation: Reform Beliefs, Sensemaking, and Social Networks

Abstract: *Utilizing a cognitive perspective, this article examines the social processes through which teachers come to understand the Common Core State Standards. The authors begin by identifying three beliefs that have important implications for policy implementation: self-efficacy, resource adequacy, and value for clients. They measure those beliefs and the Common Core discussion networks that emerge among teachers at three points in time. Through the use of SIENA models, the authors explore how networks and beliefs coevolve within schools. Unlike prior research on social networks, which consistently finds strong homophilous tendencies, this research finds no evidence that teachers seek out coworkers who hold similar beliefs. Rather, teachers relied on preexisting formal and informal relationships to guide interactions. Those interactions were characterized by social influence, whereby a teacher's own beliefs adapted toward the beliefs held by the members of their social network. The findings offer a novel perspective on the complex dynamic that occurs within organizations as new policies are unveiled and employees interact with one another to understand the changes those policies entail.*

Practitioner Points

- Individual policy beliefs, which shape implementation decisions and behaviors, are socially constructed and legitimized.
- When faced with large-scale policy change, bureaucrats engage one another in a collective sensemaking process characterized by peer dialogue and discussion.
- While discussion networks emerge when new policy is introduced, they are influenced by preexisting informal and formal relationships within the organization.
- Bureaucrats both seek and are sought for discussions based on their own efficacy in understanding the policy, their perception of resource adequacy for implementation, and the value they see in the reform.
- Over time, individual policy beliefs assimilate toward the beliefs held by peers. This suggests that central members of an organization's informal network carry significant weight in shaping collective beliefs.

The existence of street-level discretion is well documented. Research examining frontline bureaucratic behavior has focused primarily on the role of individual attributes, organizational attributes, and client characteristics (May and Winter 2009; Riccucci 2005). Two related areas have received less attention: the personal beliefs that bureaucrats hold toward a particular policy prior to implementation and the social processes and interactions that influence the formation of those beliefs. The first relates to what Goldman and Foldy refer to as the “the space before action, or the processes through which [frontline workers] make choices about how to proceed” (2015, 166–67). In “the space before action,” street-level bureaucrats form perceptions of a new policy, and those beliefs, in turn, influence their implementation behavior (Hill 2003; Kelly 1994; May and Winter 2009; Sandfort 2000; Tummers and Bekkers 2014).

The second concerns the role of social networks in shaping street-level beliefs and behavior. Research suggests that individual beliefs within organizations are socially constructed (Ibarra and Andrews 1993; Salancik and Pfeffer 1978). Therefore, the appropriate unit of analysis for the study of reform beliefs is not the individual but rather the social network (Erickson 1988, 99). Recent scholarship on frontline workers stresses the need to move beyond analyzing street-level bureaucrats as independent actors toward research that situates them as members of a social system (Gofen 2014; Keiser 2010). Hill contends that “[h]ow—and from whom—local actors come to understand what reforms mean in terms of their everyday actions is of crucial importance, for those understandings will shape the policy that ultimately gets delivered to clients” (2003, 266). This suggests that the use of discretion and divergence from intended policy is not a phenomenon that occurs individual by individual

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(Gofen 2014). Rather, bureaucratic beliefs are influenced by and legitimized through social interactions (Coburn 2001; Moulton and Sandfort 2016).

We take a cognitive approach to policy implementation and draw on the sensemaking literature to study the formation of bureaucratic beliefs in the face of reforms. How bureaucrats come to understand a reform and develop a set of reform-related beliefs are key dimensions in the implementation process (Spillane, Reiser, and Reimer 2002). From this perspective, we aim to make three contributions to the existing literature. First, given the important influence that beliefs have on the actions of implementing agents (Hill 2003; Kelly 1994; Sandfort 2000), we aim to identify particularly salient beliefs and model the social and individual factors that influence them. Thus, rather than viewing reform beliefs as a predictor of policy divergence, we hold beliefs as an outcome to be explained. This cognitive approach adds an additional dimension to traditional research on policy implementation and bureaucratic discretion.

Second, based on theories of collective sensemaking, we identify the implementing agent's social network as a critical factor in belief formation. We argue that both the structure of the network (i.e., how central or active an individual is in the network) and the composition of the network (i.e., the beliefs and attributes of one's peers) are capable of shaping bureaucratic beliefs. Despite the important connections between social interactions in the workplace and policy implementation, only a handful of studies in public administration have investigated the social networks of street-level workers (Kapucu, Hu, and Khosa 2014). We identify factors that influence street-level relationships and explore mechanisms by which workplace networks can shape attitudes toward policy reform.

Third, because of the reciprocal nature of the relationship between one's social interactions and one's beliefs, we study belief formation and network formation simultaneously. Research suggests that individuals form beliefs through social interaction while also positing that the beliefs individuals hold determine their patterns of social interaction (Marsden and Friedkin 1993; Schulte, Cohen, and Klein 2012). To capture these interdependent processes, we track the evolution of street-level beliefs toward a large-scale policy reform and the social networks established to make sense of the reform.

The setting for our study is an urban fringe public school district in California. Across three time points, we track educators' social networks and reform beliefs related to the initial implementation phases of the Common Core State Standards (CCSS) in eight schools. Our study offers insight into the "space before action" by modeling how beliefs and reform-related social networks emerge and coevolve in public organizations at the very beginning of a policy reform. Our results indicate that one's own beliefs, peers' beliefs, and social network structure influence each other. These findings highlight the complex dynamics occurring within organizations as new policies are unveiled and employees interact with one another to understand and assess the implications for their work.

Research Setting

Until recently, the United States did not have a set of national education standards. While the No Child Left Behind Act set national proficiency goals in math, reading, and science, the content for which students would be tested was determined by the states. This created significant differences in both the content and the rigor of the state standardized exams. The Common Core standards developed by the National Governors Association and the Council of Chief State School Officers were designed to provide a set of national standards that would apply equally across the states in order to improve student readiness for college and career (Common Core State Standards Initiative 2013). As of March 2017, the standards had been adopted by 42 states and the District of Columbia. While scholars have explored the specific content of the CCSS and examined its potential impact (Hiebert and Grisham 2012; Hiebert and Mesmer 2013), how educators come to understand the reform and their capacity for implementation have received little attention.

The Common Core standards offer a unique opportunity to study bureaucratic belief formation because of the discretion afforded teachers (Sandfort and Moulton 2015, 167) and the scale of the reform. Common Core marks a significant shift in our education system. The new standards require districts and teachers to considerably alter their curriculum, instruction, and assessments (Coburn, Hill, and Spillane 2016). While organizational change is often met with resistance, it can be particularly troubling to teachers, who may interpret the change as a signal that what they were doing previously in their classrooms was wrong (Spillane, Reiser, and Reimer 2002). Thus, the Common Core standards bring significant concern and uncertainty among those on the front lines charged with implementation and therefore serve as an occasion for sensemaking as teachers seek to understand the reform and its implications for their work (Coburn 2001; Weick 1995).

In California, the CCSS implementation plans were approved by the State Board of Education in March 2012. The implementation process in California was to consist of three phases carried out over a period of years: (1) the awareness phase (initial planning), (2) the transition phase (building resources, needs assessment, professional development), and (3) the implementation phase (alignment of curriculum, instruction, and assessment to the CCSS) (California Department of Education 2014). Data collection for this project

began at the start of the 2012 school year, just as the district was beginning the initial awareness phase of the reform.

Bureaucratic Beliefs and Policy Implementation

The beliefs that people hold are a central determinant of their actions (Bandura 1997). Meta-analyses reveal a strong correlation between an individual's beliefs and observed behaviors (Kim and Hunter 1993). Likewise,

how street-level bureaucrats perceive a policy has a profound impact on implementation (May and Winter 2009; Meyers and Vorsanger 2003). Reform beliefs not only shape what teachers and other frontline workers think they are capable of doing and what is worth doing but also provide an important source of authority for those actions.

Our study offers insight into the "space before action" by modeling how beliefs and reform-related social networks emerge and coevolve in public organizations at the very beginning of a policy reform.

Moulton and Sandfort (2016) identify beliefs as one of the four main sources of authority that legitimize implementation practices. For example, in her implementation study of the California Reading Initiative, Coburn (2006) found that many school staff in the early grades felt that certain strategies did not apply to them. Through their discussions, a collective belief emerged that reassured their position and legitimized their perception that these strategies, although part of the reform, were not applicable to their work. As Moulton and Sandfort (2016) suggest, rather than being sanctioned by external actors and sources, legitimate authority is endogenous to the implementation system and context. Individuals interpret policy in unintended ways, and shared beliefs can act as a source of authority, legitimizing street-level divergence from intended policy.

While the importance of perceptions and beliefs on implementation behavior is widely acknowledged, little research has focused on the origin and evolution of these beliefs (Oberfield 2010, 2014). We know much more about how individual beliefs and value systems affect policy decisions than we do about how those belief and value systems form. This is especially true with regard to the social context in which beliefs arise, in particular, how bureaucrats are influenced by the attitudes and beliefs of their peers. Much of the research on implementation and bureaucratic behavior views beliefs as static predictors of other outcomes. Our study takes a different view as we seek to understand how beliefs emerge and evolve over time. We begin by identifying three categories of beliefs that are particularly influential for implementation: beliefs about one's own ability to carry out the intended policy (efficacy), beliefs about the adequacy of resources provided to support implementation (resources), and beliefs about the value and potential positive impact of the policy for one's clients (value).

CCSS Beliefs: Efficacy

Self-efficacy is defined as a person's perception of his or her ability to successfully complete work tasks and obtain specific goals (Bandura 1997; Skaalvik and Skaalvik 2010). Self-efficacy beliefs are important factors in shaping how people think, feel, and behave (Bandura 1997). Research on teacher self-efficacy has linked the concept to both teacher motivation and teacher behavior in the classroom as well as to student performance (Tschannen-Moran and Hoy 2001, 2007; Tschannen-Moran, Hoy, and Hoy 1998). These findings reinforce the connection between cognitive beliefs and individual behavior, especially in educational settings.

In regard to policy reform, Liou, Moolenaar, and Daly (2015) note that higher levels of self-efficacy have been linked to teachers' willingness to implement curricular reform (Cerit 2013) and experiment with new practices in their classrooms (Guskey 1988; Stein and Wang 1988). In the absence of self-efficacy, individuals often perceive the time and effort exerted on a particular task as wasted, and therefore they are less likely to pursue it (Bandura 1994). A national survey conducted by Scholastic and the Bill and Melinda Gates Foundation (2012) found that 51 percent of teachers felt they were

only somewhat prepared to implement the CCSS, and another 27 percent felt they were somewhat unprepared or very unprepared to implement the CCSS. If low levels of efficacy persist, teachers may push back against the changes required in the CCSS. As research on the implementation of educational reforms has demonstrated, when teachers do not understand a particular aspect of a policy, they tend to ignore it (Coburn 2001).

CCSS Beliefs: Resources

Gofen (2014) notes that scholars who take a rational choice perspective on implementation behavior often view street-level divergence as a coping mechanism. When confronted with limited time and resources, frontline workers may have little choice but to deviate from prescribed policy. In fact, one of the reasons why teachers adapt and transform policy, according to Coburn (2001), is that they find it to be unmanageable. Coburn found that teachers rejected policy directives when they perceived that time and other resource constraints would inhibit successful implementation. Others argue that the failure to provide sufficient resources leads to poor implementation efforts and increases stress among the implementing agents (Fernandez and Rainey 2006). Thus, in addition to an individual's perception of his or her own ability to implement a policy, perceptions of the context in which implementation takes place also matter.

While lack of resources may influence self-efficacy, it should be noted that these are distinct beliefs (Liou, Moolenaar, and Daly 2015). Teachers may have confidence in their own ability but feel that their school or community lacks resources. A quote from an elementary school teacher illustrates this point: "I'm ready for [the CCSS], but I need adequate supplies and technology if I'm going to make them work for my students" (Scholastic and Bill and Melinda Gates Foundation 2012, 19).

CCSS Beliefs: Value

Implementing agents' actions may diverge from intended policy for reasons other than perceptions of not having adequate resources or the requisite skill to conduct the tasks. Divergence is also strongly influenced by the value that the implementing agents prescribe to the reform with regard to their clients—something that Gofen (2014) describes as an "other-serving" perspective. Gofen offers two examples: nurses rejecting immunization payments because they value serving as many children as possible and teachers rejecting a curriculum change because they do not deem it beneficial for their students.

These examples underscore the fact that many street-level bureaucrats enter their profession because they value public service and are committed to serving their citizen-clients (Maynard-Moody and Musheno 2003). It is often through this client or "other-serving" lens that frontline workers explore and evaluate policy reforms. When new policy fails to align with existing frameworks regarding what is effective and useful for their clients, frontline workers may simply ignore aspects of the reform (Coburn 2001). In an earlier study on the role of beliefs in policy implementation, Kelly (1994) found that the justice-related beliefs of teachers were closely related to how

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they interacted with students. Here, policy actions were determined through the bureaucrat's vision of justice. Policies are thus filtered through one's own worldview, reconciled with existing frameworks and peer experiences, and adapted in ways that may not fit the intended policy (Spillane, Reiser, and Reimer 2002). Therefore, it is likely that bureaucrats make decisions to reject, alter, or faithfully implement a policy by coming to understand their ability to implement the policy (efficacy), the adequacy of resources available to assist them (resources), and the impact, either positive or negative, that policy will have on their clients (value). These beliefs, however, are not formed by individuals in isolation. In the following section, we explore the collective side of individual reform beliefs.

Social Networks and Belief Formation

Two competing accounts for the behavior of street-level bureaucrats are often given (Meyers and Vorsanger 2003; Spillane, Reiser, and Reimer 2002). One pegs implementing agents as utility maximizers who adapt policy in ways to better fit their own narrow self-interests. The other portrays bureaucrats as dutifully working to implement policy directives. Spillane, Reiser, and Reimer (2002) note that what is assumed in both of these accounts is that the implementers are able to clearly understand what is being asked of them and, as rational actors, choose to respond accordingly. However, for reasons both political and technical, public policy is often written in ambiguous terms without specific directions or guidance on implementation activities. For example, in her study on community policing, Hill (2003) found that while the Violent Crime Control and Law Enforcement Act was designed to increase police-citizen interactions, it did not specify the form those interactions should take. In these situations, implementing agents turn to their colleagues to make sense of their work in the face of policy change (Sandfort 2000).

Assumptions of rationality and principal-agent theory offer only partial characterizations, as they suggest that bureaucrats make individual decisions about how to respond to policy change based on the policy signal and corresponding incentives.

Traditional accounts of policy divergence are incomplete in that they fail to consider the cognitive side of reforms and the sensemaking process through which bureaucratic beliefs emerge (Coburn 2001; Spillane, Reiser, and Reimer 2002).

Sensemaking has been defined as the process through which individuals come to understand novel or uncertain situations (Maitlis and Christianson 2014; Weick 1995). Planned organizational change and policy reforms, such as the CCSS, create occasions for sensemaking (Maitlis and Christianson 2014). Ethnographic studies of policy reform and sensemaking indicate that individuals do not develop reform beliefs as isolated individuals but rather seek out peers to engage in discussions and formulate shared understandings (Coburn 2001; Sandfort 2000). Therefore, sensemaking is a social and discursive process (Weick 1995; Weick, Sutcliffe, and Obstfeld 2005).

Our study builds on many valuable ethnographic and case study accounts of sensemaking to focus on and measure the actual social

structures through which sensemaking occurs. As individuals faced with uncertainty and novel policy reforms seek out colleagues for information and discussions to reduce uncertainty, those dyadic interpersonal connections serve as the foundation for intraorganizational social networks (Borgatti and Foster 2003; Brass 1995; Raider and Krackhardt 2001). Maitlis and Christianson (2014) recently called for scholars to apply social network methods to the study of sensemaking.

That social connections can shape beliefs and behaviors is well documented in public administration (see, e.g., Hill 2003; Maynard-Moody and Musheno 2003; Moynihan and Pandey 2008; Oberfield 2014). However, the processes by which those social connections form and the mechanisms by which frontline beliefs emerge within that social context have gone largely unexamined. This leaves an important gap in our understanding of street-level implementation. If discretion is inevitable (Maynard-Moody and Musheno 2003) and shaped by beliefs (Kelly 1994), and if both beliefs and actions are shaped by an individual's social connections, then there is a need to more closely examine the interrelationship between bureaucratic beliefs and social networks.

How Beliefs Affect Network Formation

Individuals are motivated to select certain peers for help when in need of information or searching to make sense of an uncertain event (Nebus 2006). This selection process is influenced by the traits and beliefs of the network members (Kilduff and Krackhardt 2008). Discussion-seeking and advice-seeking ties are directional and involve two actors: the sender of the tie (i.e., the ego, the one seeking out a peer to discuss the reform) and the receiver of the tie (i.e., the alter). The traits of either the ego or alter can influence the likelihood of tie formation. Two mechanisms related to how ego and alter beliefs can shape network formation will be discussed: prospective action and attraction (Schulte, Cohen, and Klein 2012). A third process related to the characteristics of pairs of actors, known as a homophily, will also be addressed.

Prospective action. Individuals with positive beliefs and perceptions of the reform may be more likely to actively pursue discussion and seek advice from colleagues with regard to implementation. Because they expect the reform to be beneficial, they may feel a greater incentive to realize what the policy means for their work and how best to implement it and therefore take purposeful action (Schulte, Cohen, and Klein 2012). Thus, prospective action suggests that individuals' perception of the reform influences discussion seeking because of their interest in and anticipation of receiving beneficial information from colleagues (Schulte, Cohen, and Klein 2012). As Coburn (2001) found, when teachers did not understand or value certain parts of a reform, they simply tended to ignore them. Thus, positive beliefs (efficacy, resources, value) on part of the ego may be correlated with greater levels of reform-based social interaction.

Hypothesis 1: Teachers with more positive CCSS beliefs will tend to seek more discussion ties.

Attraction. When considering whom to seek out for advice and discussions, one important decision criterion is the potential value of the information received (Nebus 2006). Thus, if a person is actively searching for others to engage with in the hope of reducing uncertainty surrounding the policy reform, he or she may focus their efforts on individuals who hold positive reform beliefs. A peer with higher efficacy and greater knowledge of implementation resources will likely provide more valuable and useful advice and thus act as a more attractive discussion partner. We consider implementation resources to be both state and nonstate resources that one may use to aid implementation (e.g., materials, texts, tools, trainers, and technology) (Hill 2003). Viewing the tie formation process as one in which the advice seeker weighs the costs (time, effort) against the benefits (valuable information, reduced uncertainty) (Morrison and Vancouver 2000; Nebus 2006), teachers may choose to seek information from those who hold more positive CCSS beliefs.

Hypothesis 2: Teachers with more positive CCSS beliefs will tend to be the recipients of more discussion ties.

Homophily. While the individual traits of the ego and alter can affect the formation of social networks through prospective action and attraction, the similarity of those beliefs is also an important factor. The mechanism of homophily, which is the tendency for people to be attracted to those with whom they share similar traits or beliefs, is well established in the psychological and sociological literatures (Byrne 1971; McPherson, Smith-Lovin, and Cook 2001). Reaching out to similar others can aid in the establishment of trust and mutual expectations (Brass 1995) as well as reduce the potential for cognitive dissonance (Festinger 1957).

Hypothesis 3: Teachers will tend to seek discussion ties from peers who hold similar CCSS beliefs.

How Networks Affect Beliefs

Networks are not simply a consequence of beliefs but also an antecedent. The literature on social networks consistently finds that individual beliefs do not result from personal attributes alone (Borgatti and Foster 2003; Kilduff and Krackhardt 2008) but rather are molded and shaped by social connections (Brass 1995; Kilduff and Tsai 2003). For example, Daly et al. (2010) found that the uptake of educational reforms within schools and the efficacy of teachers with regard to implementation were significantly influenced by the structure of reform-related social networks. Therefore, we view network ties as the “pipes through which normative pressure and credible information flow” (de Klepper et al. 2010, 84). Given this position, we examine two primary mechanisms by which the school’s CCSS discussion network can affect individual beliefs: access and social influence.

Access. Networks serve as conduits for the transfer of information and resources. Structural position in a network determines access to needed implementation resources and consequently influences an individual’s understanding and capacity to implement reforms (Borgatti and Foster 2003; Daly 2010; Ibarra and Andrews 1993; Kilduff and Krackhardt 2008). Work by Ibarra (1993) found that network centrality was the strongest predictor of involvement in administrative innovations

within a public relations agency. Similarly, education studies of school-based social networks have linked greater teacher collaboration to improved self-efficacy and student performance (Goddard, Goddard, and Tschannen-Moran 2007; Leana and Pil 2006). These studies suggest that the active sharing and acquisition of reform-related information may improve an individual’s capacity for and confidence in policy implementation.

Hypothesis 4: Teachers who are more active in seeking out others to discuss the CCSS will tend to develop more positive perceptions of the CCSS.

Social influence. The term “social influence” captures the process by which an individual’s beliefs shift toward his or her peer group’s beliefs (Leenders 2002). In a range of contexts, scholars have found that individuals assimilate their beliefs and behaviors toward those held by members of their social network (Coleman, Katz, and Menzel 1957; Marsden and Friedkin 1993; Siciliano and Thompson 2015). Within schools, Coburn (2001) contends that teacher interpretation and adaptation of policy occurs through social interactions. When frontline workers’ beliefs begin to converge with their coworkers’ beliefs, they may sense that their opinions are more legitimate and, consequently, perceive greater authority for their implementation choices (Moulton and Sandfort 2016).

Hypothesis 5: Teachers’ CCSS beliefs will assimilate to the beliefs of the peers they form discussion ties with.

Data

The data for this study were collected at three time points between October 2012 and May 2013 from a public school district in Southern California. This article analyzes data from eight of the district’s elementary schools. Each school had a response rate of greater than 70 percent across the three time points. One school fell below the 70 percent mark on the final wave with a response rate of 68 percent, but it was retained in the data set. With regard to representativeness, the sample schools’ demographics reflected overall district demographics in terms of student ethnicity, number of English-language learner students, and free/reduced-price lunch status. In total, data from 130 educators who responded at each of the three time points were used in the analysis. The educators in the sample were 86 percent female with an average of 13.2 years of experience; 44 percent had credits beyond a master’s degree or had obtained a doctorate. Note that credits beyond a master’s degree (specifically, Masters Plus 30) is a pay-scale rank used in schools and offers teachers an additional level of certification beyond a master’s degree.

Data for the study were gathered from two sources. First, administrative data provided by the district identified the employees within each school, their full names, and formal job titles. Second, an online survey was e-mailed to the core educational team (teachers, instructional coaches, and principals) of each school at three time points. In this article, we will use the term “teacher” or “educator” to refer to the core instructional team. The online survey consisted of demographic questions, items to assess educators’ beliefs, and network questions.

Demographic Information

Aligned with previous work, the online survey collected data on variables related to experience, education, and gender (Moolenaar et al. 2012). Experience was measured based on the number of years the respondent had worked as an educator. Education was treated as a dichotomous variable indicating whether the respondent had an advanced degree.

Reform Beliefs

Three distinct dimensions of CCSS reform-related beliefs were measured: efficacy, resources, and value. These dimensions serve as a “cognitive lens” through which teachers come to understand the CCSS and make sense of their changing organizational context (Kelchtermans 2009). Each belief was measured using a Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). For efficacy, respondents were asked their level of agreement with this statement: “I have a working understanding of the Common Core Standards.” For resources, respondents were asked their level of agreement with this statement: “I have the resources and materials I need to implement the Common Core Standards.” For impact, respondents were asked their level of agreement with this statement: “I believe there is value in the Common Core Standards.”

Attitudes/Organizational Commitment

We include organizational commitment as a control variable because of its role in shaping bureaucratic behavior (Moynihan and Pandey 2007) and because more committed employees may be more willing to accept and value the reforms they are charged with implementing. Organizational commitment was measured using an eight-item scale. Representative items adapted from Rosenholtz (1991) include the following: “I would be very happy to spend the rest of my career at this school,” “This school has a great deal of personal meaning for me,” and “I think that I could easily become as attached to another school as I am to this one.”

Social Networks

We focus on the role of informal discussion networks because these networks are linked with more thoughtful, ongoing dialogue (Coburn 2001). Although teachers engage with colleagues outside their school and district, it is the local school network that is most proximate and most closely tied to implementation practices (Coburn 2001). Educators in the eight schools were provided with a roster listing each of their colleagues in the school. To delineate the Common Core discussion network, the respondents were asked to check the names of the coworkers they had sought out in the past month to discuss the CCSS. Respondents could check the names of as many colleagues as they wanted. For each wave of the survey, responses were stored in school-specific binary matrices. Each cell in the matrix indicates either the presence (denoted by a 1) of a discussion-seeking tie from educator *i* to educator *j* or its absence (denoted by a 0). Using the same approach, survey respondents were also asked to indicate their close friends within the school. Descriptive statistics and correlations for the individual level variables at wave 1 are provided in tables 1 and 2. Descriptive statistics for each of the networks are displayed in table 3.

The descriptive statistics in table 1 reveal that there was a considerable amount of discussion among teachers. The average teacher reported more than four peers whom they went to for

Table 1 Descriptive Statistics of Wave 1 Data

Variable	Mean	SD	Min.	Max.
1. Number of CCSS discussion ties sought (out-degree)	4.23	3.71	0	21
2. Number of CCSS discussion ties received (in-degree)	4.23	2.70	0	16
3. Education (Masters Plus 30/doctorate)	0.44	0.50	0	1
4. Experience	13.21	8.09	0.5	35
5. Organizational commitment	4.25	0.77	1.5	5.6
6. CCSS value	5.01	0.82	2	6
7. CCSS resources	3.32	1.50	1	6
8. CCSS efficacy	4.43	0.98	1	6

Table 2 Correlation Table for Wave 1 Data

	1	2	3	4	5	6	7	8
1. Discussion ties sought	1							
2. Discussion ties received	0.52	1						
3. Education	0.02	0.20	1					
4. Experience	0.07	0.07	0.31	1				
5. Organizational commitment	0.17	0.26	-0.05	-0.05	1			
6. CCSS value	0.31	0.42	0.17	-0.10	0.21	1		
7. CCSS resources	0.27	0.35	0.15	-0.20	0.21	0.25	1	
8. CCSS efficacy	0.34	0.37	0.15	-0.24	0.17	0.39	0.45	1

Table 3 Descriptive Network Statistics

School Site	Size	Network Density at Time 1	Network Density at Time 2	Network Density at Time 3	Tie Changes from Wave 1 to Wave 2	Tie Changes from Wave 2 to Wave 3
1	11	0.55	0.35	0.34	34	27
2	25	0.23	0.23	0.21	92	99
3	15	0.25	0.26	0.31	42	46
4	14	0.17	0.17	0.20	27	31
5	13	0.46	0.26	0.26	45	45
6	19	0.26	0.17	0.21	49	37
7	11	0.11	0.26	0.43	23	20
8	22	0.18	0.18	0.15	54	62

Notes: *Size* is the number teachers who responded to all three waves and thus the number of nodes in the network. *Tie change* is the sum of the number of ties in the network that either went from not being present to being present (i.e., teacher *i* did not seek teacher *j* at wave 1 but did seek teacher *j* at wave 2) or went from being present to not being present (i.e., teacher *i* sought teacher *j* at wave 1 but did not seek teacher *j* at wave 2). The tie change values are used to calculate the Jaccard index, which is a measure of stability in the network. As Ripley et al. (2015) note, ideally, Jaccard values should be 0.3 or higher for use with the SIENA models that we employ. Of the 16 transition periods in our data, only two were slightly below the 0.3 value (school site 5 from wave 2 to 3 was 0.29 and school site 7 from wave 1 to 2 was 0.28).

discussion of the CCSS in the past month. However, there was also significant variation in social interaction. Some teachers did not go to anyone to discuss the CCSS, and others went to as many as 21 other teachers. The mean values at wave 1 across the three beliefs suggest that while educators tended to have a generally positive view of the value of the reform, they were less certain of their capacity to implement it and of the resource adequacy in their school. Lastly, educators’ perceptions of the CCSS showed stark differences, with standard deviation in beliefs as high as 1.5 for CCSS resources.

As shown in table 3, the school discussion networks ranged in size from 11 to 25 educators. While some of the schools experienced larger changes in density over time, other schools were relatively stable. However, the stability in density masks the amount of tie

churn occurring within the network. For instance, in school site 2, the network density stayed between 0.21 and 0.23 at each wave, but more than 90 ties were broken or formed between those waves. Overall, teachers were fairly active in changing ties as they engaged in the collective sensemaking process. It is this social behavior, and the factors influencing reform beliefs, that we model in the following sections.

Analytical Strategy

Suitable analytic techniques for analyzing the coevolution of beliefs and networks have only recently been developed (Snijders, van de Bunt, and Steglich 2010). In order to simultaneously explore the factors that shape discussion tie selection and peer influence on CCSS beliefs, a stochastic actor-oriented model was implemented using the RSiena (Simulation Investigation for Empirical Network Analyses) program in R, often referred to as SIENA models. SIENA models condition parameter estimates on the observed structure in the first wave and therefore assess the changes that occur in network ties and beliefs between waves. The model is a continuous-time Markov chain, and parameters are estimated through a series of simulations (Snijders, van de Bunt, and Steglich 2010).

SIENA models of the coevolution of networks and beliefs have two primary components: a set of network selection terms that identify the rules for network tie formation (i.e., social selection) and a set of variables and social influence terms that identify the rules for belief change (i.e., social influence). In the context of this study, there are rules governing the discussion ties sought by educators and rules governing changes in educator beliefs. These two components are referred to as the *network evaluation function* and the *behavioral evaluation function* (which we will term the *belief evaluation function*). Based on the language and notation in Ripley et al. (2015, 103, 130), a network evaluation function for teacher *i* is defined as follows:

$$f_i^{net}(x) = \sum_k \beta_k^{net} s_{ik}^{net}(x)$$

where β_k^{net} represents the parameters and s_{ik}^{net} the effects. An online appendix to this article, modeled after Steglich, Snijders, and Pearson (2010), contains additional information on how each effect is defined. Similarly, the behavioral/belief evaluation function for actor *i* is defined as follows:

$$f_i^{beh}(x) = \sum_k \beta_k^{beh} s_{ik}^{beh}(x, z)$$

where β_k^{beh} represents the parameters and s_{ik}^{beh} the effects.

Variables in the Network Evaluation Function

The network evaluation function contains both selection effects and structural effects. Hypotheses 1–3 posit different ways in which beliefs may influence network structure. These selection effects for CCSS beliefs were estimated for each of the mechanisms proposed. They include *CCSS belief ego* (i.e., the beliefs of the sender of the discussion tie) to test the mechanism of prospective action. The coefficient on ego's CCSS beliefs indicates the extent to which educators with more positive beliefs nominate a larger number of peers as discussion partners (hypothesis 1). The variable *CCSS belief alter* (i.e., the beliefs of the receiver of the discussion tie) assesses the mechanism of attraction as it indicates the extent to which

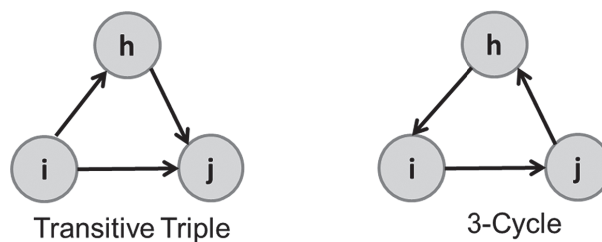


Figure 1 Triadic Structures

educators with more positive beliefs tend to be more frequently sought as discussion partners (hypothesis 2). Finally, *CCSS belief similarity* indicates the extent to which educators engage in reform discussions with others who hold similar beliefs (hypothesis 3). A separate model was run for each of the three CCSS beliefs (efficacy, resources, and value).

The structural effects in the model are endogenous effects that depend on the configuration of the network. They are included to control for structural dependencies inherent in network data, but they are of interest themselves because they capture the self-organizing properties of workplace relations. Four structural effects are included in the model: reciprocity, transitive triplets, 3-cycles, and out-degree activity. These are recommended for inclusion in most SIENA models (Snijders, van de Bunt, and Steglich 2010). The reciprocity term captures the increased likelihood of an *i, j* tie forming given the presence of a *j, i* tie. Transitive triplets and 3-cycles are two alternative ways in which subsets of three educators can be connected. As shown in figure 1, the transitive-triplet effect captures the tendency for the *i, j* tie to form given an indirect tie or two path that connects *i* and *j* via *h*. This pattern of triadic closure is generally seen as hierarchal, given that *i* tends to also seek advice from the person that his or her advisor (*h*) seeks advice from (*j*). Another effect related to triadic structure, the 3-cycle, is the opposite of transitive closure, as it measures the tendency for nonhierarchal patterns to form (Veenstra et al. 2013). In many applied settings, research has found tendencies toward hierarchal ordering, especially with advice-based discussion networks, and thus the coefficient for transitive triplets is often positive, while the coefficient for 3-cycles is negative (Lusher, Koskinen, and Robins 2013).

The out-degree activity effect is used to control for the dispersion of the degree distribution, as it captures the tendency for those with high out-degrees (i.e., those seeking a large number of discussion ties) to seek additional ties (Ripley et al. 2015). Lastly, a density parameter, known as out-degree, is also included in the model. This variable functions similarly to an intercept term in a standard linear model and captures the generally tendency for ties to form in the network.

We also incorporated a range of additional selection effects. The variable *friendship tie* indicates how much more likely a teacher is to seek discussions with a peer who is also a friend. Data on friendship ties were included in the study because such affective ties have been seen as precursors to the formation of instrumental ties (Lazega and Pattison 1999; Siciliano 2015). Moreover, friendship ties are often based on mutual trust, accessibility, and shared interests, and thus the inclusion of friendship ties helps control for these factors, which may be important when seeking information about new reforms.

The variable *same job title* captures the extent to which homophilous ties are more likely to form. More specifically, this variable indicates whether an educator is more likely to discuss the Common Core with another who teaches the same grade or holds the same title (e.g., curriculum coach). These formal positions also act as a proxy for formal school-based networks. Because schools create grade-level teams and designate time for those teams to interact, teachers in the same grade may be more likely to seek one another out for CCSS discussions. By controlling for both friendship ties and job title as important informal and formal factors in discussion tie formation, our model allows us to more carefully assess the effect of beliefs on tie formation.

Lastly, because discussion and advice ties are often thought to be formed with peers with higher levels of experience and knowledge (Morrison and Vancouver 2000, Nebus 2006), the variables of *experience alter* and *education alter* were added to the model. The variables capture the extent to which an alter with more experience or higher education is more frequently sought out for discussion. Note that gender was not included as a covariate because of the lack of variation, as some sample schools had only one male educator.

Variables in the Belief Evaluation Function

Because of the data requirements for SIENA models, the beliefs used as dependent variables are in integer form (ranging from 1 to 6). The belief evaluation function explores how individuals change their beliefs (move up or move down) over time. The belief evaluation function includes several individual-level variables that may affect changes in CCSS beliefs, including the two primary effects highlighted by hypotheses 4 and 5. Hypothesis 4 suggests that teachers who engage in more advice and discussion seeking will hold higher beliefs because of greater knowledge and resource access. We include a measure of a teacher’s *out-degree* to evaluate how increasing centrality in the network influences beliefs. Out-degree is simply the count of the number of ties sent by a teacher. The social influence effect posited in hypothesis 5 is captured by *total belief similarity*. This term assesses the preference for educators to hold beliefs similar to the beliefs held by their peers, where the influence is proportional to the number of peers they seek discussion ties with (Ripley et al. 2015). If the effect is positive and significant, it suggests that, controlling for other individual and network-related factors, educators adjust their beliefs over time to more closely match the overall beliefs of their peers.

In addition, the model contains *educator experience*, *education*, and *organizational commitment*. These variables indicate the extent to which teachers with more experience, more education, or higher commitment tend to develop more positive beliefs. One additional network measure was included in the model: *in-degree*. In-degree measures the number of ties an educator receives from peers and is used to control for differences in advice seeking versus providing.

SIENA models utilize a rate function for tie formation and a rate function for belief change. The rate functions specify the frequency with which actors can change their networks and beliefs. Because the models are continuous-time models, they assume that actors change both their networks and attitudes between the observation periods. Finally, we control for school membership through the use of a multilevel analysis technique in RSiena that utilizes structural zeros (Ripley et al. 2015). Because there are eight schools in our analysis and we focus on the ties formed within the school, structural zeros constrain the network ties in the model to only those that occur within a school and eliminate cross-school ties.

To summarize, and to connect hypotheses to model terms, table 4 reviews our five hypotheses, associated mechanisms, and corresponding parameters and indicates the part of the model (network evaluation versus belief evaluation) the hypothesis will be tested in.

Results

Table 5 contains the results of the three SIENA models, one each for efficacy, resources, and value. For each of the parameters in each of the models the absolute value of the convergence *t*-ratios were all less than 0.1, and the overall convergence ratio was less than 0.25, indicating good convergence (Snijders, van de Bunt, and Steglich 2010). The results are separated into two sections, network evaluation and belief evaluation. The network evaluation section examines the factors that affect the choice of CCSS discussion partners and addresses hypotheses 1–3. The belief evaluation section examines the individual and social factors that influence CCSS beliefs and addresses hypotheses 4 and 5.

Network Evaluation—Selection Effects

Within the network evaluation section, there are selection effects and structural effects. The selection effects of interest concern the CCSS beliefs of the ego (hypothesis 1), CCSS beliefs of the alter

Table 4 Summary of Hypotheses, Mechanisms, Variable Names, and Evaluation Function

Hypothesis	Mechanism	Variable	Part of Model
How beliefs affect networks			
H1: Teachers with more positive CCSS beliefs will tend to seek more discussion ties.	Prospective Action	CCSS belief ego	Network evaluation
H2: Teachers with more positive CCSS beliefs will tend to be the recipients of more discussion ties.	Attraction	CCSS belief alter	Network evaluation
H3: Teachers will tend to seek discussion ties from peers who hold similar CCSS beliefs.	Homophily	CCSS belief similarity	Network evaluation
How networks affect beliefs			
H4: Teachers who are more active in seeking out others to discuss the CCSS will tend to develop more positive perceptions of the CCSS.	Access	Out-degree*	Belief evaluation
H5: Teachers’ CCSS beliefs will assimilate to the beliefs of the peers they form discussion ties with.	Social Influence	Total belief similarity	Belief evaluation

*Note: The term “out-degree” appears in both the network evaluation and belief evaluation portion of our models. Out-degree acts as an intercept in the network evaluation function, and thus it is not of theoretical interest. In the belief evaluation function, out-degree is a predictor of CCSS beliefs and indicates the relationship between networking activity and CCSS beliefs.

Table 5 Model Results for the Coevolution of Network Ties and Common Core Beliefs

	Efficacy	Resources	Value
Network Evaluation			
Rate (period 1)	6.58 (0.56)***	6.56 (0.52)***	6.52 (0.51)***
Rate (period 2)	6.90 (0.59)***	6.91 (0.60)***	6.93 (0.51)***
Out-degree (density)	-1.86 (0.08)***	-1.86 (0.08)***	-1.86 (0.08)***
Reciprocity	1.10 (0.10)***	1.13 (0.10)***	1.11 (0.10)***
Transitive triplets	0.23 (0.03)***	0.25 (0.03)***	0.23 (0.03)***
3-cycles	-0.31 (0.05)***	-0.31 (0.05)***	-0.31 (0.05)***
Out-degree activity	0.02 (0.01)***	0.02 (0.01)***	0.03 (0.01)***
Friendship tie	0.69 (0.08)***	0.67 (0.07)***	0.67 (0.08)***
Same job title	1.57 (0.19)***	1.51 (0.18)***	1.53 (0.18)***
Experience alter	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Education alter	0.14 (0.08)*	0.18 (0.08)**	0.14 (0.08)*
CCSS belief ego (H1)	0.15 (0.06)**	0.05 (0.03)*	0.04 (0.06)
CCSS belief alter (H2)	0.12 (0.06)**	-0.03 (0.03)	0.13 (0.06)**
CCSS belief similarity (H3)	-0.54 (0.41)	-0.14 (0.24)	-0.40 (0.38)
Belief Evaluation			
Rate (period 1)	1.60 (0.30)***	2.46 (0.43)***	1.48 (0.26)***
Rate (period 2)	1.28 (0.23)***	2.14 (0.37)***	1.19 (0.20)***
In-degree	0.13 (0.07)*	-0.01 (0.05)	0.25 (0.10)**
Experience	-0.01 (0.01)	-0.01 (0.01)	-0.00 (0.02)
Education	0.15 (0.19)	0.21 (0.14)	0.15 (0.24)
Organizational commitment	0.10 (0.13)	0.27 (0.10)***	-0.09 (0.14)
Out-degree (H4)	-0.04 (0.05)	0.01 (0.03)	-0.06 (0.06)
Total belief similarity (H5)	0.52 (0.31)*	0.51 (0.20)**	0.35 (0.41)
Linear shape	-0.16 (0.24)	-0.12 (0.15)	-0.46 (0.29)
Quadratic shape	-0.24 (0.09)***	-0.01 (0.04)	-0.27 (0.13)**

*** $p < .01$; ** $p < .05$; * $p < .1$.

(hypothesis 2), and similarity of CCSS beliefs (hypothesis 3). The coefficient on CCSS belief ego was positive for all three models and significant for efficacy and resources. This lends partial support to our first hypothesis that teachers with more positive views on the CCSS are likely to pursue additional discussion ties with their colleagues. The coefficient on CCSS belief alter was positive and significant for both efficacy and value. Here we find partial support for our second hypothesis that alters who hold more positive beliefs with regard to their capacity to implement the reform and the value they ascribe to the reform are more likely to attract ties. The coefficients on CCSS belief similarity are all insignificant, and the sign is in the opposite direction. Thus, we find no evidence of homophily and fail to support hypothesis 3.

Other selection effects used as controls in the model include friendship, same job title, alter experience, and alter education. The effect of friendship is positive and significant in all three models. This indicates that educators are more likely to rely on friends than nonfriends when seeking a discussion partner. This finding supports previous work suggesting that friendship is a precursor to the formation of instrumental ties (Lazega and Pattison 1999), as such relations may build on preestablished trust. We also find a large positive effect for same job title (e.g., both individuals teach first grade). Such an effect may be attributable to two factors. First, schools establish formal grade-level teams, giving teachers additional time and opportunity to interact. Second, the implications of the reform, with regard to curriculum and testing changes, will be most similar among teachers in the same grade level. Thus, because of potentially higher information relevance and accessibility, there may be additional incentives for seeking peers who teach the same grade.

Finally, the variables alter experience and alter education assess whether educators sought peers with more seniority or education for Common Core discussion. Alter experience was not significant in any of the three models. The lack of significance may reveal that for new policies and reforms for which no member of the network has any prior involvement, seniority may not be an important predictor simply because of the novelty of the reform. It could also be, given the negative correlations between experience and CCSS beliefs (see table 2), that senior members of the school perceive change less favorably and thus are less useful resources for discussion. However, alter education had a positive and significant effect in all three models, suggesting that teachers with education beyond a master's degree or with a PhD tend to attract discussion ties from their colleagues.

Network Evaluation—Structural Effects

Across each of the three models, the structural effects (out-degree, reciprocity, transitive triplets, 3-cycles, out-degree activity) are all significant. The out-degree term functions as an intercept, and the negative sign indicates that Common Core discussion ties are generally unlikely to occur in the network (i.e., the percentage chance of a teacher forming a tie is less than 50 percent). The coefficient on reciprocity suggests that ties in the discussion network tend to be reciprocated. A teacher is much more likely to form a discussion tie with a peer if that peer sought that teacher for CCSS information previously. The two triadic effects of transitive triplets and 3-cycles were both significant but in opposite directions. The positive transitive triplet effect and the negative 3-cycle effect suggest a tendency toward local hierarchy in the network as opposed to more generalized exchange. This finding aligns with previous models of advice network formation (Lusher, Koskinen, and Robins 2013) and suggests that even in instances of novel, large-scale reform, teachers tend to establish informal social structures that exhibit hierarchy.

Belief Evaluation—Attribute Effects

The second half of table 5 provides the belief dynamics. In addition to the rate parameters, which indicate the expected frequency with which actors change their beliefs, there are three variable types: attribute effects, influence effects, and belief shape. Hypothesis 4 posited that teacher centrality in the network, defined as the number of discussion-seeking ties, would have a positive influence on their CCSS beliefs due to an increase in access to implementation resources and information. The results offer no support that discussion seeking promotes higher CCSS beliefs. One reason for this is that ties may vary dramatically in the value they provide and thus, it is not simply the number of ties one is able to form but also the quality of those connections (Siciliano 2016). As will be discussed later, our results suggest that peer beliefs, rather than the number of peers, may play a larger role in changing CCSS beliefs.

The control variable of in-degree was positive and significant for efficacy and value, indicating that teachers who are sought out more for discussion tend to develop more positive beliefs. Three additional attribute effects were included in the model. These attribute effects captured how experience, education, and organizational commitment affected reform beliefs during the initial year of implementation. These terms were generally insignificant in the models, as only organizational commitment had a significant

effect on perceptions of resources needed to implement the Common Core. Individuals who reported a stronger commitment to their school tended to believe they had greater access to needed materials and resources.

Belief Evaluation—Social Influence

Total belief similarity measures the influence that peer beliefs have on an educator's own belief, proportional to the number of peers. In all three models, the influence effect is positive, and it is significant for both efficacy and resource beliefs. In other words, when the alters an educator is connected to have higher (or lower) perceptions of the Common Core, the educator's own perception tends to assimilate toward those higher (or lower) peer beliefs. Although teachers may enter the school year with individual ideas and notions regarding the CCSS, as they engage in the sensemaking process, shared beliefs begin to emerge through social influence.

Belief Evaluation—Shape Function

The negative and significant quadratic shape parameters for impact and efficacy indicate that the form of the belief objective function is parabolic. The parabolic belief function indicates that there is a negative feedback, or a self-correcting mechanism at work in the schools (Snijders, van de Bunt, and Steglich 2010). This means that, over time, educators are not drawn to extreme values on the Common Core belief variable; movement toward extremely positive beliefs or extremely negative beliefs is mitigated (Snijders, van de Bunt, and Steglich 2010, 55).

Discussion

This article sought to provide one of the first investigations of the coevolution of social networks and frontline beliefs toward a large-scale reform. Our cognitive perspective identified patterns of social interaction to model the reciprocal relationship between reform-based networks and beliefs. The study tracked the initial implementation of the CCSS in eight public schools and measured three particularly salient beliefs (efficacy, resources, and value) along with teacher networks at three time points.

The network evaluation portion of our results is suggestive of three important conclusions. First, CCSS beliefs may shape the structure of workplace relations formed by those seeking to make sense of and interpret the reform.

Teachers both seek and are sought out for discussions surrounding the CCSS based on their own efficacy in understanding the reform, their perception of resource adequacy for implementation, and the value they see in the reform, although there is variation in the ego and alter effects across the three beliefs. Relatedly, teachers did not seek peers who held similar beliefs. Given the strong prevalence for homophily in social networks, this finding was unexpected and will be addressed in more detail later. Second, preexisting informal and formal structures within the organization appear to influence patterns of interaction. Preexisting friendship ties are an important determinant of discussion tie formation. Educators likely rely on and turn to those with whom they have an established connection and mutual trust in order to reduce the social and psychological costs associated with seeking advice. However, teachers also relied

on more formal roles and relations, as noted by the positive and significant effect of holding the same job title. Finally, there are strong endogenous factors influencing network formation. Specifically, teachers tend to form reciprocal relations and develop hierarchal rather than nonhierarchal triadic structures when seeking discussions on reform implementation.

The belief evaluation portion of the model suggests another important conclusion. Social influence effects, indicated by the coefficient on total belief similarity, were present for both efficacy and resource beliefs. However, a teacher's perception of the value of the CCSS was not significantly affected by peer beliefs. This may indicate that the overall value that an individual ascribes to a reform or policy may function as a core belief that is not easily changed through social interaction. Overall, the results provide evidence that both selection effects (ego and alter beliefs influence discussion network formation) and influence effects (discussion partners' beliefs influence ego beliefs) are present within schools as teachers seek to make sense of and assess the implications of the CCSS.

From a network management perspective, one focused on successful implementation and the uptake of the reform, the results are encouraging. While prior work on coevolution models had tended to find strong tendencies toward homophily in social network formation, teachers in our study schools did not seek out peers who held similar beliefs. The lack of homophily in the discussion network counteracts a potential limitation found in most informal social networks: individuals prefer to interact primarily with others who hold similar beliefs. When strong homophily effects are present, social networks may serve only as an echo chamber for homogenous ideas on reforms. In homogenous social structures, teachers can simply rely on their preexisting and shared understandings to make sense of the reform and thus not engage in purposive reframing, reflection, and rethinking of the policy message that is needed for a deeper understanding (Coburn 2001, 156).

However, heterogeneity in groups can lead to its own problems. Coburn (2001) found that pedagogical diversity among teachers led to the avoidance of differences and, consequently, superficial dialogue, or what she refers to as outfacing conversations. Schools attempting to formally designate networks

may succeed in bringing heterogeneous views together, but those networks may lack the trust and mutual understanding needed for critical discussions. Outfacing conversations in these settings are potentially problematic for organizations undergoing policy reform as they do not lead to the in-depth discussions needed for changes in instructional practice (Coburn 2001; Hargreaves 1994). Rather, superficial discussions tended to produce symbolic implementation (Coburn 2001).

In terms of the eight study schools, we find that the Common Core discussion networks had both the positive dimensions of trust-based peer selection associated with informal networks (i.e., teachers had a tendency to seek out their friends) and heterogeneous viewpoints often associated with formal networks (i.e., teachers did not seek

Educators likely rely on and turn to those with whom they have an established connection and mutual trust in order to reduce the social and psychological costs associated with seeking advice.

peers who held similar beliefs). Together, these aspects offer the diversity and trust needed to support critical dialogue and meaning making.

The role of beliefs in selecting Common Core discussion partners is promising as well. Teachers tended to seek and receive discussion ties if they held more positive beliefs. Networking behavior was therefore more likely for those with higher CCSS beliefs. Coupled with the presence of social influence, this suggests that networks tend to be centered on teachers with more positive beliefs, and those more positive beliefs may influence the beliefs of others in the network. However, influence effects were not found for the CCSS value belief. While teachers can learn where to access implementation resources and become more certain of their ability to implement a reform, social interactions may not adjust the value they assign to the reform. Such changes in beliefs may result in single-loop rather than double-loop learning (Argyris and Schön 1978).

Conclusions

The results of our study support existing research suggesting that social networks play an important role in policy implementation (Atteberry and Bryk 2010; Daly et al. 2010). Emphasis on human capital aspects of the reform (i.e., the technical components and pedagogical strategies) and the lack of attention to how reform behaviors spread through informal social structures can hinder successful implementation (Daly et al. 2010). The high rate of failure of educational and other organizational reforms in the public sector requires researchers to more critically examine the role of attitudes, beliefs, and the “space before action” in policy implementation. As scholars of public policy and administration have long known, successful implementation is more likely to occur when those charged with implementing the policy value the change and have sufficient resources to enact it (Goggin et al. 1990). Furthermore, reforms can fail or succeed based on initial beliefs and on the existing and evolving social structures within an organization (Krackhardt 1992). Further research on belief formation and social network formation is needed in the context of policy implementation.

Understanding the factors influencing patterns of social interaction and reform beliefs that exist in the “space before action” is an important component for understanding street-level implementation decisions. Analysis of reform beliefs can help scholars and practitioners further understand frontline discretionary behavior. Did the bureaucrat not comply with a policy because she did not feel she had the resources or expertise to enact it or because she did not believe it would benefit her clients? Understanding the belief-based origins of discretionary behavior is important because it directs policy makers and managers where to spend resources and efforts in hopes of achieving successful implementation.

While the use of stochastic actor-oriented models provides some leverage for identifying selection and influence effects, there are several limitations of the study. First, the study was carried out within a single district. Variations in state context, district culture, and leadership could influence the results. Such macro-level factors offer important areas for future work. The integration of micro- and macro-levels of analysis continues to be an important

area of implementation research (Sandfort 2000). Second, while teachers comprise the largest population of street-level workers, the dynamics of how attitudes and beliefs form and coevolve with social networks may be different in other settings. Third, given the emphasis in this article on beliefs and because the Common Core was not fully implemented at the time of study, direct connections between reform beliefs and implementations behaviors could not be examined. However, extensive ethnographic research in schools has been able to link informal discussions in teacher social networks to changes in pedagogical practice in the classroom (Coburn 2001). Additional research drawing connections between beliefs and behaviors is needed, especially work that examines those connections over time.

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References

- Argyris, Chris, and Donald A. Schön. 1978. *Organizational Learning: A Theory of Action Perspective*. Reading, MA: Addison-Wesley.
- Atteberry, Allison, and Anthony S. Bryk. 2010. Centrality, Connection, and Commitment: The Role of Social Networks in a School-Based Literacy Initiative. In *Social Network Theory and Educational Change*, edited by Alan J. Daly, 51–76. Cambridge, MA: Harvard Education Press.
- Bandura, Albert, ed. 1994. *Self-Efficacy*. Vol. 4 of *Encyclopedia of Human Behavior*. New York: Academic Press.
- _____. 1997. *Self-Efficacy: The Exercise of Control*. New York: W. H. Freeman.
- Borgatti, Stephen P., and Pacey C. Foster. 2003. The Network Paradigm in Organizational Research: A Review and Typology. *Journal of Management* 29(6): 991–1013.
- Brass, Daniel J. 1995. A Social Network Perspective on Human Resources Management. *Research in Personnel and Human Resources Management* 13(1): 39–79.
- Byrne, Donn Erwin. 1971. *The Attraction Paradigm*. New York: Academic Press.
- California Department of Education. 2014. Common Core State Standards Systems Implementation Plan for California. <http://www.cde.ca.gov/re/ccl/> [accessed May 15, 2017].
- Cerit, Yusuf. 2013. Relationship between Teachers' Self-Efficacy Beliefs and Their Willingness to Implement Curriculum Reform. *International Journal of Educational Reform* 22(3): 252–70.
- Coburn, Cynthia E. 2001. Collective Sensemaking about Reading: How Teachers Mediate Reading Policy in Their Professional Communities. *Educational Evaluation and Policy Analysis* 23(2): 145–70.
- _____. 2006. Framing the Problem of Reading Instruction: Using Frame Analysis to Uncover the Microprocesses of Policy Implementation. *American Educational Research Journal* 43(3): 343–49.
- Coburn, Cynthia E., Heather C. Hill, and James P. Spillane. 2016. Alignment and Accountability in Policy Design and Implementation: The Common Core State Standards and Implementation Research. *Educational Researcher* 45(4): 243–51.
- Coleman, James, Elihu Katz, and Herbert Menzel. 1957. The Diffusion of an Innovation among Physicians. *Sociometry* 20(4): 253–70.
- Common Core State Standards Initiative. 2013. <http://www.corestandards.org> [accessed May 15, 2017].
- Daly, Alan J. 2010. *Social Network Theory and Educational Change*. Cambridge, MA: Harvard Education Press.

- Daly, Alan J., Nienke M. Moolenaar, Jose M. Bolivar, and Peggy Burke. 2010. Relationships in Reform: The Role of Teachers' Social Networks. *Journal of Education Administration* 48(3): 359–91.
- de Klepper, Maurits, Ed Sleebos, Gerhard van de Bunt, and Filip Agneessens. 2010. Similarity in Friendship Networks: Selection or Influence? The Effect of Constraining Contexts and Non-Visible Individual Attributes. *Social Networks* 32(1): 82–90.
- Erickson, Bonnie H. 1988. The Relational Basis of Attitudes. In *Social Structures: A Network Approach*, edited by Barry Wellman, and Stephen D. Berkowitz, 99–121. New York: Cambridge University Press.
- Fernandez, Sergio, and Hal G. Rainey. 2006. Managing Successful Organizational Change in the Public Sector. *Public Administration Review* 66(2): 168–76.
- Festinger, Leon. 1957. *A Theory of Cognitive Dissonance*. Stanford, CA: Stanford University Press.
- Goddard, Yvonne L., Roger D. Goddard, and Megan Tschannen-Moran. 2007. A Theoretical and Empirical Investigation of Teacher Collaboration for School Improvement and Student Achievement in Public Elementary Schools. *Teachers College Record* 109(4): 877–96.
- Gofen, Anat. 2014. Mind the Gap: Dimensions and Influence of Street-Level Divergence. *Journal of Public Administration Research and Theory* 24(2): 473–93.
- Goggin, Malcolm L., Ann O'M. Bowman, James P. Lester, and Laurence J. O'Toole, Jr. 1990. *Implementation Theory and Practice: Toward a Third Generation*. Glenview, IL: Scott, Foresman/Little, Brown Higher Education.
- Goldman, Laurie S., and Erica Gabrielle Foldy. 2015. The Space before Action: The Role of Peer Discussion Groups in Frontline Service Provision. *Social Service Review* 89(1): 166–202.
- Guskey, Thomas R. 1988. Teacher Efficacy, Self-Concept, and Attitudes toward the Implementation of Instructional Innovation. *Teaching and Teacher Education* 4(1): 63–69.
- Hargreaves, Andy. 1994. *Changing Teachers, Changing Times: Teachers' Work and Culture in the Postmodern Age, Teacher Development*. London: Cassell.
- Hiebert, Elfrieda H., and Dana L. Grisham. 2012. What Literacy Teacher Educators Need to Know about Supporting Teachers in Understanding Text Complexity within the Common Core. *Journal of Reading Education* 37(3): 5–12.
- Hiebert, Elfrieda H., and Heidi Anne E. Mesmer. 2013. Upping the Ante of Text Complexity in the Common Core State Standards: Examining Its Potential Impact on Young Readers. *Educational Researcher* 42(1): 44–51.
- Hill, Heather C. 2003. Understanding Implementation: Street-Level Bureaucrats' Resources for Reform. *Journal of Public Administration Research and Theory* 13(3): 265–82.
- Ibarra, Herminia. 1993. Network Centrality, Power, and Innovation Involvement: Determinants of Technical and Administrative Roles. *Academy of Management Journal* 36(3): 471–501.
- Ibarra, Herminia, and Steven B. Andrews. 1993. Power, Social Influence, and Sense Making: Effects of Network Centrality and Proximity on Employee Perceptions. *Administrative Science Quarterly* 38(2): 277–303.
- Kapucu, Naim, Qian Hu, and Sana Khosa. 2014. The State of Network Research in Public Administration. *Administration & Society*. Published electronically on November 6. <https://doi.org/10.1177/0095399714555752>.
- Keiser, Lael R. 2010. Understanding Street-Level Bureaucrats' Decision Making: Determining Eligibility in the Social Security Disability Program. *Public Administration Review* 70(2): 247–57.
- Kelchtermans, Geert. 2009. Who I Am in How I Teach Is the Message: Self-Understanding, Vulnerability and Reflection. *Teachers and Teaching* 15(2): 257–72.
- Kelly, Marisa. 1994. Theories of Justice and Street-Level Discretion. *Journal of Public Administration Research and Theory* 4(2): 119–40.
- Kilduff, Martin, and David Krackhardt. 2008. *Interpersonal Networks in Organizations: Cognition, Personality, Dynamics, and Culture, Structural Analysis in the Social Sciences*. Cambridge: Cambridge University Press.
- Kilduff, Martin, and Wenpin Tsai. 2003. *Social Networks and Organizations*. London: Sage Publications.
- Kim, Min-Sun, and John E. Hunter. 1993. Attitude-Behavior Relations: A Meta-Analysis of Attitudinal Relevance and Topic. *Journal of Communication* 43(1): 101–42.
- Krackhardt, David. 1992. The Strength of Strong Ties: The Importance of Philos in Organizations. In *Networks and Organizations: Structures, Form, and Action*, edited by Nitin Nohria, and Robert G. Eccles, 216–39. Boston: Harvard Business School Press.
- Lazega, Emmanuel, and Philippa E. Pattison. 1999. Multiplexity, Generalized Exchange and Cooperation in Organizations: A Case Study. *Social Networks* 21(1): 67–90.
- Leana, Carrie R., and Frits K. Pil. 2006. Social Capital and Organizational Performance: Evidence from Urban Public Schools. *Organization Science* 17(3): 353–66.
- Leenders, Roger Th. A. J. 2002. Modeling Social Influence through Network Autocorrelation: Constructing the Weight Matrix. *Social Networks* 24(1): 21–47.
- Liou, Yi-Hwa, Nienke M. Moolenaar, and Alan J. Daly. 2015. Developing and Assessing Educator Beliefs about the Common Core. *Educational Assessment, Evaluation and Accountability* 28(4): 377–404.
- Lusher, Dean, Johan Koskinen, and Garry Robins. 2013. *Exponential Random Graph Models for Social Networks: Theory, Methods, and Applications*. New York: Cambridge University Press.
- Maitlis, Sally, and Marlys Christianson. 2014. Sensemaking in Organizations: Taking Stock and Moving Forward. *Academy of Management Annals* 8(1): 57–125.
- Marsden, Peter V., and Noah E. Friedkin. 1993. Network Studies of Social Influence. *Sociological Methods & Research* 22(1): 127–51.
- May, Peter J., and Søren C. Winter. 2009. Politicians, Managers, and Street-Level Bureaucrats: Influences on Policy Implementation. *Journal of Public Administration Research and Theory* 19(3): 453–76.
- Maynard-Moody, Steven, and Michael Musheno. 2003. *Cops, Teachers, Counselors: Stories from the Front Lines of Public Service*. Ann Arbor: University of Michigan Press.
- McPherson, Miller, Lynn Smith-Lovin, and James M. Cook. 2001. Birds of a Feather: Homophily in Social Networks. *Annual Review of Sociology* 27: 415–44.
- Meyers, Marcia K., and Susan Vorsanger. 2003. Street-Level Bureaucrats and the Implementation of Public Policy. In *Handbook of Public Administration*, edited by B. Guy Peters, and Jon Pierre, 153–64. London: Sage Publications.
- Moolenaar, Nienke M., Peter J. C. Slegers, Sjoerd Karsten, and Alan J. Daly. 2012. The Social Fabric of Elementary Schools: A Network Typology of Social Interaction among Teachers. *Educational Studies* 38(4): 355–71.
- Morrison, Elizabeth Wolfe, and Jeffrey B. Vancouver. 2000. Within-Person Analysis of Information Seeking: The Effects of Perceived Costs and Benefits. *Journal of Management* 26(1): 119–37.
- Moulton, Stephanie, and Jodi R. Sandfort. 2016. The Strategic Action Field Framework for Policy Implementation Research. *Policy Studies Journal* 45(1): 144–69.
- Moynihan, Donald P., and Sanjay K. Pandey. 2007. Finding Workable Levers over Work Motivation: Comparing Job Satisfaction, Job Involvement, and Organizational Commitment. *Administration & Society* 39(7): 803–32.
- . 2008. The Ties that Bind: Social Networks, Person–Organization Value Fit, and Turnover Intention. *Journal of Public Administration Research and Theory* 18(2): 205–27.

- Nebus, James. 2006. Building Collegial Information Networks: A Theory of Advice Network Generation. *Academy of Management Review* 31(3): 615–37.
- Oberfield, Zachary W. 2010. Rule Following and Discretion at Government's Frontlines: Continuity and Change during Organization Socialization. *Journal of Public Administration Research and Theory* 20(4): 735–55.
- Oberfield, Zachary W. 2014. *Becoming Bureaucrats: Socialization at the Front Lines of Government Service*. University Park: University of Pennsylvania Press.
- Raider, Holly, and David Krackhardt. 2001. Intraorganizational Networks. In *Companion to Organizations*, edited by Joel A. C. Baum, 58–74. Oxford, UK: Blackwell.
- Riccucci, Norma M. 2005. Street-Level Bureaucrats and Intrastate Variation in the Implementation of Temporary Assistance for Needy Families Policies. *Journal of Public Administration Research and Theory* 15(1): 89–111.
- Ripley, Ruth M. 2015. In *Manual for RSiena*, edited by Tom A.B. Snijders, Zsófia Boda, Andras Vörös, and Preciado Paulina. Oxford, UK: University of Oxford.
- Rosenholtz, Susan J. 1991. *Teachers' Workplace: The Social Organization of Schools*. New York: Teachers College Press.
- Salancik, Gerald R., and Jeffrey Pfeffer. 1978. A Social Information Processing Approach to Job Attitudes and Task Design. *Administrative Science Quarterly* 23(2): 224–53.
- Sandfort, Jodi R. 2000. Moving beyond Discretion and Outcomes: Examining Public Management from the Front Lines of the Welfare System. *Journal of Public Administration Research and Theory* 10(4): 729–56.
- Sandfort, Jodi R., and Stephanie Moulton. 2015. *Effective Implementation in Practice: Integrating Public Policy and Management*. San Francisco: Jossey-Bass.
- Scholastic and Bill and Melinda Gates Foundation. 2012. Primary Sources: 2012: America's Teachers on the Teaching Profession. https://www.scholastic.com/primarysources/pdfs/Gates2012_full.pdf [accessed May 15, 2017].
- Schulte, Mathis, N. Andrew Cohen, and Katherine J. Klein. 2012. The Coevolution of Network Ties and Perceptions of Team Psychological Safety. *Organization Science* 23(2): 564–81.
- Siciliano, Michael D. 2015. Advice Networks in Public Organizations: The Role of Structure, Internal Competition, and Individual Attributes. *Public Administration Review* 75(4): 548–59.
- _____. 2016. It's the Quality Not the Quantity of Ties That Matters: Social Networks and Self-Efficacy Beliefs. *American Educational Research Journal* 53(2): 227–62.
- Siciliano, Michael D., and James R. Thompson. 2015. If You Are Committed, Then So Am I: The Role of Social Networks and Social Influence on Organizational Commitment. *Administration & Society*. Published electronically on November 30. <https://doi.org/10.1177/0095399715617987>.
- Skaalvik, Einar M., and Sidsel Skaalvik. 2010. Teacher Self-Efficacy and Teacher Burnout: A Study of Relations. *Teaching and Teacher Education* 26(4): 1059–69.
- Snijders, Tom A. B., Gerhard G. van de Bunt, and Christian E. G. Steglich. 2010. Introduction to Stochastic Actor-Based Models for Network Dynamics. *Social Networks* 32(1): 44–60.
- Spillane, James P., Brian J. Reiser, and Todd Reimer. 2002. Policy Implementation and Cognition: Reframing and Refocusing Implementation Research. *Review of Educational Research* 72(3): 387–431.
- Steglich, Christian, Tom A. B. Snijders, and Pearson Michael. 2010. Dynamic Networks and Behavior: Separating Selection from Influence. *Sociological Methodology* 40(1): 329–93.
- Stein, Mary Kay, and Margaret C. Wang. 1988. Teacher Development and School Improvement: The Process of Teacher Change. *Teaching and Teacher Education* 4(2): 171–87.
- Tschannen-Moran, Megan, and Anita Woolfolk Hoy. 2001. Teacher Efficacy: Capturing an Elusive Construct. *Teaching and Teacher Education* 17(7): 783–805.
- _____. 2007. The Differential Antecedents of Self-Efficacy Beliefs of Novice and Experienced Teachers. *Teaching and Teacher Education* 23(6): 944–56.
- Tschannen-Moran, Megan, Anita Woolfolk Hoy, and Wayne K. Hoy. 1998. Teacher Efficacy: Its Meaning and Measure. *Review of Educational Research* 68(2): 202–48.
- Tummers, Lars, and Victor Bekkers. 2014. Policy Implementation, Street-level Bureaucracy, and the Importance of Discretion. *Public Management Review* 16(4): 527–47.
- Veenstra, René, Jan Kornelis Dijkstra, Christian Steglich, and Maarten H. W. Van Zalk. 2013. Network–Behavior Dynamics. *Journal of Research on Adolescence* 23(3): 399–412.
- Weick, Karl E. 1995. *Sensemaking in Organizations: Foundations for Organizational Science*. Thousand Oaks, CA: Sage Publications.
- Weick, Karl E., Kathleen M. Sutcliffe, and David Obstfeld. 2005. Organizing and the Process of Sensemaking. *Organization Science* 16(4): 409–21.

Supporting Information

A supplementary appendix may be found in the online version of this article at <http://onlinelibrary.wiley.com/doi/10.1111/puar.12797/full>.