Architectures for Learning: A Comparative Analysis of Two Urban School Districts

MARY KAY STEIN  
University of Pittsburgh

CYNTHIA E. COBURN  
University of California, Berkeley

This article explores the usefulness of communities of practice theory for understanding how districts can create organizational environments that foster teachers' opportunities to learn the new ideas and practices required to carry out ambitious reforms. It draws on data from a longitudinal study of the implementation of ambitious mathematics curricula in two urban districts. By analyzing the contrasting ways that teachers in two schools in each district were linked to each other and reform efforts at the district level, the article shows how the district reform effort in one district led to significant opportunities for teacher learning and alignment with reform goals while efforts in the other district coordinated action but failed to spur meaningful opportunities for teacher learning. The article closes with implications for policy and practice.

Introduction

Since the 1990s, educational researchers have increasingly come to see the problem of educational reform as one of learning. In particular, scholars point to the ways that new federal, state, and local policies often require implementers to learn new ways of carrying out their work (Cohen and Barnes 1993). The learning demands on teachers have become especially intense as policy makers have increasingly set their sites on classroom instruction and put forth visions of instruction that depart substantially from many teachers’ existing practice (Cohen and Hill 2001; EEPA 1990; Spillane et al. 2002). Unlike additive reforms (e.g., compensatory education for Title I students), today’s policies demand transformation of the core of teachers’ instructional
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practices—transformations that require considerable effort, time, and support (Thompson and Zeuli 1999).

This problem of learning has fallen squarely into the laps of district leaders. Once viewed as the main obstacle to reform, districts are now being asked to oversee instructional improvement on a heretofore unprecedented scale (Hightower et al. 2002). Many have responded by adopting uniform curricula and providing increased levels of professional development. Others have established integrated programs for students and staff guided by common frameworks for curriculum, instruction, assessment, and learning climate (Newman et al. 2001). All have insisted that staff modify curriculum to align with state standards and assessments. Despite all of this activity, the questions remain: Are teachers actually learning the knowledge and skills required to transform their practices? And, if so, what role has the district played in creating the opportunities for that learning?

The most common approaches used to study policy implementation are not poised to answer these questions. First, they are often couched in frameworks that fail to account for the role that teachers’ learning plays in the implementation of new programs and practices (Spillane et al. 2002). These frameworks assume that teachers understand fundamental aspects of reform as intended by policy makers; failures of implementation are explained by factors that lay outside the learning process, such as lack of supervision or monitoring, policy ambiguity, or the autonomy of teachers who are viewed as acting solely in their own best interest (e.g., Weatherly and Lipsky 1977).

Second, many studies take the formal structure of the educational system (i.e., state policy-making entities, district policy-making entities, designated school leaders, and grade-level teacher teams) as a given and cast opportunities or constraints for instructional improvement as laying within that formal representation of the system. For example, in their study of district strategies for managing high-quality professional development, Desimone and colleagues (Desimone et al. 2002) focused on, among other things, teacher participation in formal committees at various levels of the system. Not considered were teachers’ informal collaborations or the roles played by informal leaders at

Mary Kay Stein is professor at the School of Education and senior scientist at the Learning Research and Development Center, both at the University of Pittsburgh. Her areas of expertise include the study of classroom instruction, teacher learning, and the relationship between policy and practice. Cynthia E. Coburn is assistant professor in policy, organization, measurement, and evaluation at the Graduate School of Education, University of California, Berkeley. Her research uses the tools of organizational sociology to understand the relationship between instructional policy and teachers’ classroom practices in urban schools.
the school level. Studies such as these also tend to identify the central problem
of educational reform as the lack of alignment across formal hierarchical
elements of the system (e.g., state standards, district policy, and the design
of professional development) and call for remedies aimed at strengthening the
coherence between and among these elements (e.g., more consistent, specific,
authoritative, powerful, and stable policies [Porter 1994]). These approaches
do not consider the role that informal networks (Coburn 2001; Frank and
Zhao 2004; Penuel et al., forthcoming) play in how teachers apprehend and
learn to implement new programs. Moreover, their focus on top-down align-
ment is silent with respect to the kinds of engagement within and across various
elements of the system that might lead to better or worse kinds of alignment,
that is, brittle forms of compliance versus implementation based on teacher
understanding of the principles underlying the policy.

In this article, we explore the usefulness of a particular theoretical lens—
communities of practice as embedded in organizations—for understanding
how districts can create organizational environments that foster teachers’ op-
opportunities to learn the new ideas and practices required to carry out ambitious
reforms (Wenger 1998; Wenger et al. 2002; Wenger and Snyder 2000). Follow-
ing Wenger (1998), we call such environments “architectures for learning.”
The underlying idea being that, while district leaders cannot force or guarantee
teacher learning, they can design the conditions that will be supportive of the
kinds of interactions that will provide opportunities for meaningful teacher
learning. We find this approach useful because it is rooted in learning theory;
at the same time, it recognizes the importance of alignment in large-scale,
district-led improvement efforts. Alignment is conceptualized not in terms of
top-down consistencies but rather by a particular form of engagement, en-
gagement that—while inspired by goals set at the top of the organization—
involves active meaning making on the part of workers on the shop floor.

This article builds on our earlier work where we characterized districts as
multiple overlapping communities of practice (Coburn and Stein 2006). Most
districts, we argued, are made up of many distinct communities of practice
including, but not limited to, a district leadership community, a school principal
community, a community of staff developers or coaches, and a whole host of
teaching communities (Cobb et al. 2003; Spillane 1998; Wechsler 2001). We
argued that educational reform could be viewed as an attempt by one com-
unity of practice (district leadership) to influence the practice of other com-
unities (e.g., teachers’ informal communities within schools). Because district
leaders seldom interact directly with the teacher communities they seek to
influence, they identify or create “stuff” that embodies their vision (e.g., cur-
rricular frameworks, directives, or procedures) and launch them on journeys
that cross the boundaries of a variety of communities (i.e., they “travel” from
central office to principals to coaches to teachers). In addition, leaders create
opportunities for interaction between various communities of practice (e.g., joint workshops for coaches and principals). Because of the many boundary crossings that must be negotiated as people and “stuff” move across these disparate communities, we propose that opportunities for teacher learning are determined not only by teacher-teacher interactions within their local communities but also by the nature of connections between their local communities and other communities in the district.

The purpose of this article, then, is to investigate and elaborate the mechanisms by which connections between communities mediate teachers' opportunities to learn in response to district policy. We do this by probing the nature of connections between the central office communities and local teacher communities in two similar initiatives located in two different urban districts. Although both were focused on the implementation of a new standards-based mathematics program, their methods for “rolling out” their respective initiatives were very different. On the one hand, the connections that were forged in one district meaningfully linked participants across disparate communities, leading to significant opportunities for teacher learning and alignment with reform goals. On the other hand, the connections created in the other district coordinated actions but did not spur meaningful opportunities for teacher learning.

District Reform as Learning

Prior research on teachers’ learning in response to policy suggests that teachers have a tendency to gravitate toward approaches that are congruent with their prior practices (Spillane 2000), to focus on surface manifestations (such as discrete activities, materials, or classroom organization) rather than deeper pedagogical principles (Coburn 2004; Spillane 2000; Spillane and Callahan 2000; Spillane and Zeuli 1999; Stein et al. 1996), and to graft new approaches onto existing practices without altering classroom norms or routines (Cuban 1993). However, most of this research has focused on teachers as individuals, often in isolation from their organizational contexts.

Other research has examined the influence of teachers’ professional communities on reform implementation. These studies have noted that professional communities are a crucial site for learning (Franke and Kazemi 2001; Gallucci 2003; Little 1982, 2003; McLaughlin and Talbert 2001; Smylie and Hart 1999; Stein and Brown 1997; Stein et al. 1998) and have provided evidence that teachers’ organizational context and patterns of interaction shape how they learn (Coburn 2001; Hill 2001; McLaughlin and Talbert 2001; Spillane 1999). However, this research has paid scant attention to the process by which learning in community occurs.  

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Here we turn to sociocultural learning theory to investigate the processes and dynamics of teacher learning in collaborative settings. In contrast to conventional views of learning as an individual psychological process, sociocultural theorists argue that learning occurs as individuals participate in social and cultural activities (Rogoff 1990) using tools shaped by sociohistorical practices (Wertsch 1998). Sociocultural theorists are part of a broader intellectual tradition of contextual and culturally situated theories of mind and practice that include activity theory (Engestrom et al. 1999), cultural psychology (Cole 1996), and situated learning (Greeno and Middle School Mathematics through Applications Project Group 1998).

Within this broader intellectual tradition, we draw on a specific theory of situated learning in which the central concept and unit of analysis is community of practice (Lave and Wenger 1991; Wenger 1998). We do so because community of practice scholars’ analyses of how learning occurs through participation in everyday work practices lends insight into how teachers might learn through participating in informal and formal work groups in the school. In the communities of practice perspective, learning occurs in the fields of social interaction between people within microcommunities of practice as they go about their daily work (Lave and Wenger 1991; Wenger 1998). Opportunities for teacher learning, therefore, may be explained by examining the teachers’ interactions as they plan lessons, discuss challenges, and seek assistance.

The early applications of communities of practice theory to teacher learning drew primarily from Lave and Wenger’s initial formulation of communities of practice (1991). Lave and Wenger’s seminal contribution was the identification and description of communities as sites for the learning of novices through “legitimate peripheral participation,” viewed at the time as a significant extension of sociocultural theory beyond cognitive apprenticeship (Brown et al. 1989). As such, most education studies focused on teacher learning as movement from peripheral to more central forms of participation within school-based, microcommunities of practice (see, e.g., Stein et al. 1998). However, Wenger (1998) subsequently extended this theory to situate these microcommunities as a mid-level unit of analysis between formal organizational structures and the behaviors of individuals on the shop floor (Gallucci 2003). As such, this more recent formulation provides the conceptual apparatus that allows us to investigate the relationship between teacher interaction in microcommunities and the external structures of the district, something that was hidden from view in earlier formulations.

Often, but not always, communities of practice develop as networks of informal relationships that are not congruent with formal organizational structures (Brown and Duguid 1991; Coburn 2001; Vaughan 1996; Wenger 1998). Thus, it is important to distinguish analytically between formal organizational structures and the informal relationships that make up communities of prac-
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tice. Wenger (1998) refers to formally designated roles, divisions of labor, policies, procedures, and management systems as the designed organization. He contrasts the designed elements of organizations with the lived organization, which consists of interconnected communities of practice. This distinction allows us to go beyond focusing on conventional arrangements and to uncover and illuminate the role that informal networks play in creating opportunities for teacher learning.

Learning within communities of practice.—Learning within communities of practice is conceptualized as the ways in which communities gradually transform their practices through on-going negotiation of meaning. This negotiation of meaning, according to Wenger (1998), occurs through the dynamic interrelationship of participation and reification. Participation, as in common usage, is defined as engaging in (or taking part in) some activity or enterprise. Although Wenger defines reification more broadly, in this article, we use the term reification to mean a concrete object that embodies a set of ideas or processes. A typical example would be curricula, the tangible pages of which make up a “record” that can be used to guide or monitor instructional practice. Curricula (reifications) provide a useful counterpoint to teaching practice (participation) because they reify or “hold steady” a set of ideas and processes across time and space.

The meanings embodied in reifications, however, are always partial. Individuals (especially those who come from communities other than the community that created the reification) imbue them with different meanings and various degrees of significance. When a community engages with a reification, it serves as a “point of focus” around which the negotiation of meaning (learning) occurs. In fact, reifications can be viewed as requiring participation to make them meaningful in the context of on-going practice. By the same token, participation also requires reification to be meaningful. Otherwise, participation becomes a string of experiences without anchoring or mooring, and there is no mechanism by which to uncover and coordinate differences in meaning among members. Thus, it is the interplay of reification and participation that creates new possibilities for the negotiation of meaning and new opportunities for communities to adjust their participation, renegotiate meanings, and continue to develop their shared repertoire over time.

Learning between communities of practice.—The social landscape of a district is made up of multiple, overlapping communities of practice. Each has its own shared history of learning, histories that create discontinuities—boundaries—between those who share the history and those that do not. These boundaries reveal themselves by the learning that is required to cross them. It is difficult for individuals to “pick up” the talk or tasks of an unfamiliar community because the meanings that are invested in them are rooted in unspoken, tacit understandings that have developed over a long period of coparticipation.
In system-wide reform efforts, district leaders are faced with the daunting task of fostering roughly similar forms of learning across hundreds of professionals—professionals who belong to diverse communities of practice. Leaders typically do this by creating reifications that are shared with the diverse communities and by providing opportunities for individuals from different communities to interact with one another. When reifications traverse multiple communities, they are called boundary objects. For example, pacing guidelines produced by a district central office and then passed along to coaches who, in turn, introduce them to teachers would be considered to be a boundary object. Because the guidelines are meant to be used by multiple communities of practices and sit at the nexus of perspectives, they—as do all boundary objects—have the potential to coordinate perspectives and spur similar forms of learning across multiple communities (Star and Griesemer 1989).

When a boundary object is introduced into diverse communities, however, the originator (in this case, the district central office) has limited control over how it will be interpreted and used by the various communities. Using a boundary object to orchestrate learning across disparate communities requires processes of coordination and translation between and among those communities. Rather than expecting that diverse communities will interpret a boundary object as intended by the central office, leaders must anticipate the need for and design activities that promote the development of synchronized understandings through cross-community meaning making. These activities are best captured with Wenger’s concept of “alignment” (Wenger 1998, 178–81), where the work of alignment is seen as “bridging time and space to form broader enterprises so that participants become connected through the coordination of their energies, actions, and practices” (Wenger 1998, 179). Such connections allow individuals to situate their actions within a shared vision and to feel motivated to engage in action in concert with others to achieve goals larger than those that may be immediately visible within their own communities.

The Work of Alignment

Alignment—or, more precisely, the lack of it—is a key culprit in most policy analysts’ explanations for failed policy (Desimone et al. 2002; Porter 1994; Smith and O’Day 1991). Unlike the policy analysts’ approach to alignment, however, a community of practice framework recognizes that there are different methods of achieving alignment—methods distinguished by the nature of the engagement that occurs at the boundaries of communities. In addition, a community of practice approach to alignment does not privilege formally designated organizational groups (the designed organization) but rather ex-
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amines the processes of alignment between and among networks of informal relationships (the lived organization).

According to Wenger, the work of alignment involves boundary spanning between and among multiple communities. In addition to boundary objects, it relies on brokers (individuals who use their memberships in multiple communities to carry practices between them) and boundary practices (regular, on-going forums for mutual engagement for individuals from different communities, the purpose of which is to sustain a connection across boundaries). Just as opportunities to learn within communities of practice are created by the interplay of reifications and participation, so, too, opportunities to learn across communities of practice are created by the interplay of boundary objects (reifications) and brokers and boundary practices (forms of participation).

Frequently, teacher communities of practice are expected to learn from district reform initiatives in ways that rely heavily on reification—for example, when teachers encounter policy solely in the form of boundary objects such as a new curriculum. Reifications alone, while efficient for reaching large numbers of people, have limited effectiveness in coordinating meanings because there is not enough overlapping experience between the communities that created the reification and the community that encountered it to create a “coordinated, relevant, or generative meaning” (Wenger 1998, 65). In cases of insufficient participation, Wegner predicts that teachers’ relations to the broader enterprise will be literal and procedural; alignment will center on compliance rather than participation in meaning.

The intentional balancing of participation and reification represents a different strategy for alignment, one that devotes as much attention to who participates and in what ways as to the design of boundary objects. In this approach to alignment, communities are encouraged to coordinate their practices by exploring their boundaries in ways that mutually expand their possibilities for learning. In so doing, they are “forced to perceive [their] own positions in new ways, to have new questions, to see things [they] have never seen before, and derive new criteria for competence that reflect the alignment of practices” (Wenger 1998, 218). Instead of demanding their compliance, this approach to alignment asks communities to connect to the organization’s broader efforts through mutual engagement and the investment of their creative energy to achieve the organization’s goals.

Following Wenger (1998), we argue that alignment is a key ingredient of large-scale, coordinated forms of learning. Without it, the energies and actions of different communities cannot be galvanized into socially organized action toward a common purpose. New forms of engagement that occur inside of local microcommunities of practice are likely to provide opportunities for learning within that particular community, but they will not—on their own—connect those opportunities to the broader enterprise of whole-district reform.
Thus, alignment is—or should be—a central consideration in district leaders’ architectures for learning (Wenger 1998).

Research Design and Methodology

In this article, we examine the processes of alignment by investigating the nature of connections that were formed across multiple communities within two separate districts. We analyze these connections in terms of the interplay between boundary objects and opportunities to participate (brokers and boundary practices), seeking to understand how trade-offs between reification and participation affected the process of alignment and, ultimately, the opportunities for learning within local microcommunities of practice. We begin by examining the nature of each district’s learning architecture, that is, their formal designs for teacher learning and the enactments of those designs. Next, we examine the “lived” communities of practice (communities made up of teachers, coaches, and/or principals) and describe the ways in which meanings were negotiated within and between these local lived communities. We then use the contrasts between the two districts—both in terms of their designs for learning and the nature of their lived communities—to advance our understanding of the ways in which the interplay of boundary objects and opportunities for cross-community participation compose an important feature of districts’ architectures for learning.

The patterns reported herein are based on data collected as part of a larger study that examined the interactions among district strategy, human and social capital, type of curriculum, classroom instruction, and student learning in two districts. The Greene School District, an urban district in the western United States, adopted the Investigations in Data, Number, and Space curriculum in the summer of 2003. Region Z, in the New York City public school system, adopted the Everyday Mathematics curriculum at the same point in time. Each district expected all of its elementary schools to use their respective curriculums and all of its teachers to participate in professional development. Both districts have a history of underachievement in mathematics and serve high-poverty neighborhoods that include large numbers of recent immigrants.

Based on recommendations from the district directors of mathematics, we selected four schools in each district (p 8) with varying levels of professional community and teachers’ expertise. For the analysis reported here, we focused on two schools in each district (p 4): the school nominated as having high professional community and high teacher expertise in each district and the school nominated as having low professional community and low teacher expertise in each district. We selected the two schools at the extremes of our sample to be certain that we understood the relationship between the district’s
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learning architectures and teachers’ experiences in their communities of practice in schools with diverse organizational conditions.

All four schools in this analysis had a high percentage of students who qualified for free or reduced-price lunch. Consistent with the demographics of their region, the schools in Region Z had a majority of African American students and the schools in Greene had a majority of Latino students. The two schools in Greene also had a higher percentage of English-language learners than those in Region Z. See table A1 in appendix A for information about the case study schools.7

Data Collection

The data used for the present study were collected between Fall 2003 and Spring 2005, which coincided with the first two years of the reform in each district. To gather information about the district-designed architectures for learning, we interviewed district leaders in mathematics, observed professional development, and analyzed key documents. In New York City, we interviewed the deputy chancellor once, the director of mathematics two times, and that director’s assistant for elementary mathematics once. We also interviewed the leader directly charged with overseeing elementary mathematics instruction in Region Z two times and the regional superintendent of that region once. In Greene, we interviewed the superintendent once and the director of mathematics two times, and we interviewed three key teacher leaders in the district one time each. District-level interviews focused on the district’s strategy for mathematics reform, including the description of and reasons for adopting particular curricula; the structure of professional learning opportunities; the relationship between curriculum, assessment, and pacing guides; expectations for implementation; and the role of school leaders, coaches, and other key personnel in the implementation process. Interviews lasted from 45 to 90 minutes. All interviews were taped and transcribed. In addition to interviews, we observed district-led meetings and professional development sessions in both districts (14 full days in New York City; 10 full days in Greene). We took ethnographic fieldnotes for each observation. Finally, we collected relevant district documents related to mathematics instruction, including pacing guides, assessments, memos to teachers, professional development materials, and so forth.

At the school level, we focused attention on six focal teachers within each school (# p 24). These teachers were selected to represent a range of attitudes toward the curriculum and a range of grade levels present in the school. For each teacher, we conducted five interviews and six classroom observations per year. We supplemented work with focal teachers with two interviews a year with the mathematics coach (# p 6 coaches), two interviews per year with

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the school principal (4 principals), one interview per year with six additional teachers in each school (which we call nonfocal teachers; 24 additional teachers), as well as observations of 3–5 occasions in each school where teachers interacted on matters of mathematics instruction (professional development, grade-level meetings, coaching sessions, etc.; 17). School-level interviews lasted from 30 minutes to 90 minutes, and all were taped and transcribed. All observations were captured using ethnographic fieldnotes.

A subset of this data collection was designed specifically to investigate the nature and boundaries of teachers’, coaches’, and principals’ participation in communities of practice. We used an egocentric approach to social network analysis to map the boundaries of teachers’ communities of practice and the nature of connections between communities. In the egocentric approach, the analyst maps networks that are centered around an individual or social unit (the ego; Wellman 1993; Wellman and Berkowitz 1988). To do this, we interviewed each focal teacher, coach, and principal using questions designed to find out who each individual talked with about mathematics instruction, the frequency and content of their interaction, and why they talked with some people and not others (see app. B for questions used in this part of the study).

We then analyzed these data and selected to interview in each school an additional six teachers (nonfocal teachers) who were part of focal teachers’ social networks. During the subsequent visit to the school, we interviewed these nonfocal teachers using the same battery of social network questions as used for the focal teachers, supplemented with questions on their use of curriculum and background in mathematics.

The strength of the egocentric approach is that, rather than making assumptions about the nature and form of teachers’ networks, we took identification of teachers’ networks as an essential first step for empirical study. To date, most research on social relations among teachers has focused on the school as the unit of analysis or on formal organizational structures like grade-level groups. Yet, we know that professional community may be unevenly distributed throughout a school (Bidwell and Yasumoto 1999; Coburn 2001; Yasumoto et al. 2001) and that, in some circumstances, informal networks are more consequential than formal organizational structures as places where teachers interact with one another (Brown and Duguid 1991; Coburn 2001; Frank and Zhao 2004; Reagans and McEvily 2003; Wenger 1998). Because the analyst maps teachers’ networks from the ground up, the egocentric approach has the potential to avoid some of the pitfalls of many existing studies of teachers’ professional communities (Carrasco et al. 2006; Reagans and McEvily 2003).

Once we identified teachers’, coaches’, and principals’ social networks, we focused attention on the nature of interaction that happened in these communities, conscious of the fact that not all gatherings of teachers could be
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considered a community of practice (Wenger 1998; Wenger et al. 2002). To capture the nature of interaction within social networks, we interviewed teachers, coaches, and principals about what they talked about with others in their network. We then supplemented the interviews by observing occasions where focal teachers, coaches, and principals interacted with colleagues identified in their social network interviews, including professional development, teacher meetings, coaching sessions, informal interaction during lunchtime, and leadership team meetings.

Data Analysis

To analyze district-designed architectures for learning, we analyzed interviews, observations, and district artifacts to determine (a) the formally designated roles and structures for supporting mathematics reform and (b) how those roles and structures actually played out, that is, the nature of the interactions that characterized their enactments. To do so, we identified key boundary objects related to mathematics (including curricula, pacing guides, assessments, etc.), boundary practices (including professional development that brought together individuals from different segments of the district), and brokers (individuals whose roles required them to cross multiple communities). We were particularly interested in the ways in which boundary objects, boundary practices, and brokers were used to forge connections between different segments of the district. We analyzed the similarities and differences between the two districts’ designs in terms of their directionality, inclusively, and the forms of engagement they fostered.

We took several steps to identify communities of practice at the school level. First, we used social network analysis to determine the boundaries of focal teachers’, coaches’, and principals’ social networks. We then analyzed the social network data to determine which networks actually constituted communities of practice. Wenger and colleagues (2002) define communities of practice as those that have three qualities: shared domain, regular interactions, and shared practice. To determine if a teachers’ social network did in fact constitute a community of practice, we assessed the degree to which it had all three of these attributes.9

Shared domain refers to the key issues or problems that the community commonly experiences. It is the common ground that brings them together. The social network data collection process was designed to elicit networks that possessed a shared domain. We asked teachers to identify others with whom they interacted around mathematics instruction in particular. In this way, we assured that teachers identified individuals who were focused on the shared domain of mathematics instruction and, more specifically, on figuring out what
the new mathematics curricular mandates meant for their teaching and student learning.

Second, communities of practice must have regular interactions, as they are necessary to create the social fabric of community; in order to build a community, individuals must interact with some frequency on issues important to their domain. To analyze the degree to which interaction with others in a social network was regular, we queried teachers on the frequency with which they interacted with each person that they identified in their social network. To be considered a community of practice, teachers needed to interact with others in their network at least once a month.

Third, communities of practice engage in shared practice, or a set of socially defined ways of doing things in the domain, a set of common approaches for guiding “what they do together as a community.” In order to identify the presence of shared practice, we coded the content of interaction for what we call routines of interaction. Following Feldman and Pentland (2003), we define routines as “repetitive, recognizable patterns of interdependent actions, carried out by multiple actors” (95). By analyzing interview and observational data, we identified 292 instances across the four schools where focal teachers, coaches, and school principals interacted with others in their communities. We analyzed each instance for the nature of the routines of interaction that teachers engaged in. We determined that a social network had shared practice if individual routines were repeated multiple times across events such that no individual routines occurred less than 10 percent of the time.10 Of the multiple, overlapping communities that we identified using social network analysis, only 56 percent met all three criteria for a community of practice. In the analysis that follows, we include only those communities that met all three criteria.

Once we identified the communities of practice in the case study schools, we then analyzed each community along a number of dimensions. First, we analyzed the extensiveness of the ties. Here, we were interested in the size of the community and the degree to which it included individuals in different areas of the school and beyond the school. Second, to determine the nature of the alignment, we analyzed the focus of the conversation and congruence with approaches promoted by the district. To capture the focus of conversation, we used a coding scheme that we developed through systematic, iterative coding (Miles and Huberman 1994; Strauss and Corbin 1990). We began with codes that described, with little interpretation, the focus of interaction. We grouped together categories using the constant comparative method (Strauss and Corbin 1990) until we ended up with a final set of codes, including student learning, pacing/coordination, sharing materials, and discussing the nature of mathematics, among others.

For congruence, we developed separate indicators for each curriculum based on an in-depth analysis of the curriculum conducted by members of the
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research team (Stein and Kim, forthcoming). For example, Everyday Mathematics relies on a spiral structure where lessons that happen later in the sequence depend upon material that was covered earlier. Because of this design, conversations where teachers gave one another advice about skipping particular lessons were deemed incongruent. In contrast, Investigations has a modular design. The curriculum does not require that teachers use all units, and there is flexibility in the order that units are employed. Because of this different design, conversations where teachers give one another advice about skipping a unit would not be considered incongruent in Greene.

After analyzing the dimensions of communities within schools, we then used matrix displays (Miles and Huberman 1994) to compare patterns, first between schools and then between districts. In spite of the fact that we selected schools that were nominated as having high professional community and low professional community, we discovered that the most significant variation occurred between districts rather than between schools within a given district on the dimensions we measured here. Thus, major findings are reported by district rather than by individual school, although we take care to note when there are differences in patterns between schools as they occur.

Several methodological features of the study ensure that the patterns reported here represent patterns present in the research sites. These strategies include intensive immersion at the research sites (Eisenhart and Howe 1992; Lofland and Lofland 1995), systematic sampling of interaction (Miles and Huberman 1994), efforts to explore countervailing evidence (Miles and Huberman 1994), and systematic coding of data (Miles and Huberman 1994; Strauss and Corbin 1990).

Findings

We begin this section with a review of the designed organizations, that is, the systems that district leaders put into place to support teachers and other professionals who were expected to carry out the reforms. Then we transition to a discussion of findings related to the lived organizations, that is, how individuals actually interacted around mathematics within their informal communities of practice.

District Learning Architectures: The Designed Organization

Designed organization in Region Z.—With the onset of mayoral control and the appointment of Joel Klein as chancellor in 2003, the New York City public school system began a major transformation. The entire New York City system
was reorganized from 32 community school districts into 10 large regions, each of which was overseen by a regional superintendent. At the same time, the entire district embarked on major new system-wide reforms in both mathematics and literacy. Within mathematics, this transformation was marked by the appointment of a new director of mathematics, the adoption of Everyday Mathematics as the district-wide curriculum, the installation of mathematics coaches, and the creation of a variety of professional development opportunities for teachers and coaches. All elementary schools, with the exception of 200 so-called “waiver” schools, were expected to participate in the new mathematics instructional program.

Three primary groups of individuals were responsible for aligning the mathematics reform across the system: the central office mathematics leadership team, the regional instructional specialists, or RISs (one elementary math RIS was assigned to each of the 10 regions), and coaches (one mathematics coach was assigned to each elementary school). Figure 1 identifies the formally designed activities that lay at the intersections of these three groups and between these groups and teachers.

Regularly occurring events within the intersecting areas of figure 1 represent opportunities for individuals at different levels of the system to engage in cross-level conversation. For the purposes of this article, we identify these cross-level conversations as boundary practices between “formally designated” communities of practice. For example, the district mathematics leadership team engaged in boundary practices with the regional instructional specialists in all-day monthly meetings (upper left intersection). District leaders’ interactions with coaches occurred for one week each summer (upper right intersection). Coaches were primarily connected to district leadership through biweekly training sessions led by their RIS (shown by the small intersecting area between RISs and coaches in the middle of the diagram). Finally, the teacher’s primary link into this system of interlocking boundary practices was the coach assigned to his or her school (lower right intersection), who was responsible for providing regular professional development sessions and for assisting teachers as they implemented the new program.

Boundary objects also played an important role in the alignment of professional learning across the district. These included the Everyday Mathematics curriculum materials and the Comprehensive Approach to Balanced Mathematics, or CAB. Everyday Mathematics was, of course, their adopted K–6 curriculum; it included a guide for teachers, student workbooks, and a teacher reference manual. Its ubiquitous use in the boundary practices noted on figure 1 confirms its status as a boundary object—an artifact that, although interpreted and used differently by members of various communities, helped to align leaders’, RISs’, coaches’, and teachers’ activities. The CAB was a pacing
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![Diagram of Architectures for Learning]

Fig. 1.—Boundary practices in New York City’s Region Z

guide created by district leaders. It, too, was referenced regularly during the boundary practices shown in figure 1.

Our observations of district-led monthly RIS meetings suggest that the intention of these meetings was to encourage individuals to negotiate the meaning of Everyday Mathematics and the CAB in ways that made sense for their communities and, in turn, the communities with whom they were entrusted to work. For example, in the second RIS meeting of year one, one of the central office mathematics leaders acknowledged the fact that district leaders were able to reach teachers only in an indirect and mediated manner: “This [monthly RIS meeting] is the main venue that Central has for talking through you [the RIS] to coaches and teachers.” She went on to discuss how the monthly meetings would fail if they became simple hand-offs of training materials to RISs, who, in turn, simply handed them off to the coaches. Rather, she said, “we have to go into it and really understand it together”; as such,
she was acknowledging the need to negotiate the meaning of the boundary objects in ways that would allow the RISs, in turn, to meaningfully represent them to, and discuss them with, their coaches (November 2003 RIS meeting).

Biweekly full-day coach training represented the opportunity for the Region Z RIS to “broker” the information she had learned in the monthly district-led meetings to her coaches. Our observations of RIS-coach interactions during these meetings again suggested the intention to strive for meaningful participation. Coaches were expected, in turn, to broker information from the district, as mediated through their RIS, during their encounters with teachers and others in their home schools. These encounters include both working with individual teachers and holding biweekly after-school professional development sessions for all of the teachers in the school.

In New York City’s learning architecture, then, RISs and coaches—along with the Everyday Mathematics curriculum itself and the CAB—were intended to serve as key links between the district and teachers. Three things stand out as noteworthy about the design of these connections. First, RISs were responsible for a large number of coaches. Each region was made up of approximately 100 schools, of which the majority were elementary schools. Thus, RISs were responsible for overseeing the work of over 60 elementary mathematics coaches. District leadership recognized the challenge of this task. As stated by one district leader, “I know that the big thing that I am hearing over and over that seems so difficult . . . is that a RIS is responsible for many, many schools, I think many of them feel many more schools than they could ever possibly get to.”

Second, despite intentions to the contrary, most of the connections between communities were unidirectional, the underlying idea being the “turn-key model.” As stated by the city-wide leader for elementary mathematics when asked about the design of support for the math reform, “the [central office leaders] would work with RISs and RISs would then essentially be the staff developers of the math coaches, who would then . . . it was sort of, kind of a turn-key, turn-key, turn-key kind of thinking. Coaches would then turn-key and work with their teachers.”

Third, the entire cascading structure (central office math leadership to RISs to coaches to teachers) occurred outside the administrative line. Parallel to the cascading, interlocking boundary practices for mathematics that we have just described was another set of interlocking boundary practices for administrators: the deputy chancellor worked with regional superintendents, who, in turn, worked with local instructional superintendents, who, in turn, worked with principals. However, few if any crossovers occurred between the two cascading structures. For example, the training of new, aspiring, and veteran principals throughout the city had been turned over to a new entity, the Leadership Academy, and the mathematics department had limited success.
obtaining significant blocks of time on the Leadership Academy’s agendas for city-wide principal meetings. Similarly, at the regional level, the mathematics training of principals appeared to take a back seat to literacy training. According to the Region Z RIS, although the regional superintendent held monthly principal meetings, only one (as of April 2004) had been devoted to mathematics, and it had been run by an external consulting group. Finally, within schools, no provision was made for leadership teams composed of administrators and coaches; there was no dedicated time for meetings, nor did administrators and coaches receive training for how they might work together to carry out instructional improvement in the school.

Returning to the boundary practices represented in figure 1, it is interesting to note that our observations of the practices that occurred within them converged—over time—into a remarkably similar image. There were early attempts during monthly district-led RIS meetings to engage participants in open-ended mathematics problems, watch videotapes of lessons, and examine student work.16 Similarly, during the first year of the reform, the Region Z RIS devoted time to having coaches work on open-ended mathematics problems. However, these kinds of activities decreased precipitously in the second year. By the second year, the leaders of boundary practices tended to use similar strategies to engage participants in focusing on the key boundary object—Everyday Mathematics. Most of the professional development we observed, whether it was meant for RISs, coaches, or teachers, engaged adults in learning how to use the Everyday Mathematics materials or how to manage those materials with respect to typical challenges, such as parental communications, grading, or teacher-expressed concerns. For example, typical topics of the all-day RIS meetings included making sense of Everyday Mathematics’s distinctions between Beginning, Developing, and Secure skills, bridging between Everyday Mathematics assessments and city-wide report card structures, demonstrating how the games in Everyday Mathematics should be used, and discussing issues related to the pacing guidelines. Similarly, the RIS-led professional development for coaches—in the second year—tended to focus on how to use the materials. Finally, our observations of school-based professional development, as well as teachers’ comments about them, suggest an emphasis on learning to navigate through the materials. For example, in one after-school professional development that we observed, the coach spent the entire 90 minutes leading teachers through the various parts of the *EM Assessment Handbook* and suggesting how they might use them.

The boundary practices also consistently focused on issues of coordination, especially using the CAB to assure coverage of city and state standards. Teachers consistently received the message that (a) they could not and should not skip any lessons and that (b) they needed to keep up with the pacing schedule in the CAB. As stated by the city-wide director of mathematics: “They [the
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teachers] like the fact that we have said to them, ‘If you follow this pacing
[in the CAB] you will cover everything and we have checked it and double
checked it for you.’ I think they get a certain amount of comfort from that.
. . . We basically say to people, ‘Look, if you follow the pacing for the first
year, you know, as you get to know the program, this will continue to get
better.’” Similarly, in the Summer 2005 district-wide training for coaches, the
session leader warned the coaches that teachers would want to jump around
in the curriculum. She went on to warn coaches not to allow them to do that:
“They must follow the pacing chart.”

Described organization: Greene School District.—In the Greene School District,
the vision for mathematic reform was similarly bold. In 2002, the district,
under the direction of a new superintendent, appointed an elementary math-
ematics curriculum review committee and charged them with creating a “uni-
ified educational program” in mathematics. Before that there had been no
district curriculum, and the superintendent felt the need for coherence. They
selected the curriculum Investigations in Data, Number, and Space (hereafter,
Investigations) and designed a rollout beginning in Fall 2003 that expected
all teachers to be using all modules of the curriculum within two years.

Similar to New York City, Greene initiated a range of professional develop-
ment to support teachers’ and other professionals’ learning surrounding the
new mathematics curriculum. These professional development experiences
crossed levels of the system to involve nearly all individuals with instruction-
related roles and to move teachers’ classroom practice into alignment with
the new district curriculum. Figure 2 illustrates the design of these boundary
practices.

Similar to Region Z’s, the coaching in the Greene School District repre-
sented a major way to link communities of practice in schools with district
leaders. However, unlike Region Z’s initiative, where there was one full-time
coach in each school, Greene had two mathematics coaches per school, each
of whom taught half time in their classroom and acted as a mathematics coach
for the other half of their time. Coaches were connected to the district through
participation in a series of professional development experiences, monthly
meetings with the director of mathematics, and periodic visits to the school
by the director of mathematics, during which she coached the coaches as they
worked with teachers. Coaches, along with their principals, also participated
in district-led leadership team training. A smaller subset of the coaches also
participated in district-level tasks, such as serving on the curriculum adoption
committee, creating the pacing guide, and developing and revising the district-
wide formative assessments.

Coaches, in turn, were connected to their schools through their participation
with their school principals and assistant principals on the school-based lead-
ership teams and in their work coaching individual teachers, working with
teacher teams on planning, during Math Labs,¹⁷ and providing professional development on early-release Thursdays once or twice a month.¹⁸ Finally, coaches were also half-time teachers and thus were connected to their schools as members of the teaching faculty.

As in New York City, in the Greene School District boundary objects also played a key role in aligning professional learning across the district. In this case, leaders turned to a trio of boundary objects: the adopted curricular materials (Investigations), district-developed quarterly math assessments (QMAs), and a pacing guide (also referred to as the blueprint) meant to coordinate the curricular materials and the QMAs with each other and with state standards and assessment.

The district curriculum was organized by grade-level objectives that were linked to the state standards. Investigations was viewed as the program that was used to achieve those objectives; that is, it was viewed as a tool to meet the objectives/curriculum, not as the curriculum in and of itself. In addition,
the district had developed the QMAs as a formative assessment tool to measure the extent to which students were meeting the objectives spelled out in the pacing guide and covered in the Investigations curriculum modules. This pacing guide also placed primacy on the “objectives,” then identifying which Investigations modules to use to achieve them and providing suggested time frames.

Thus, Greene’s learning architecture relied on coaches and a trio of boundary objects to serve as the key link between the district and its teachers. The design of this link included several noteworthy features. First, there were a large number and a wide variety of interlocking connections between the coaches and the district, on the one hand, and between the coaches and the school, on the other hand. Second, the linkages were bidirectional. Various boundary practices brought coaches up into the district to engage in district policy making around pacing schedules and QMAs; at the same time, other boundary practices brought district policy makers into schools to provide support and professional development to coaches in the context of their local communities. Third, coaches were connected to the schools at the leadership level (through participation in the newly designed leadership team structure), the grade level (via grade-level teams), and the individual teacher level (via in-class coaching).

In addition to the work with coaches, the district also created connections to school leaders via their work with school leadership teams. First, the director of mathematics was provided time during monthly district-wide principal meetings to discuss Investigations and to work with school leaders on issues of mathematics content and teacher learning. But the school leaders—principals and assistant principals—also participated in professional development as a team with their building coaches in leadership team trainings. The leadership team was a new organizational structure instituted in the schools during the first year of efforts to scale-up the new mathematics and literacy curricula. The principal, assistant principal, literacy coaches, and mathematics coaches were to meet weekly to discuss curriculum implementation and to plan professional development.

The members of the leadership team also attended district-wide professional development for the leadership team together. These opportunities—which happened the last Thursday of every month—tended to be content—rather than management—focused. While a small portion of these meetings was typically devoted to issues of coordination, most of the time was spent focusing on mathematics and literacy teaching and learning. Several such meetings that we attended were rich with examples of student work, talk about mathematics instruction, and discussion about the use of district objectives and standards. In one of these meetings, the director of mathematics began the meeting by referring to some prior guidelines set by the group to help teachers
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with “pulling the big ideas” about mathematics from lessons. She then passed out several examples of student work, asking with each example for participants to tell her “what the mathematics is here.” During the discussion of these examples, which took about an hour, participants talked about what student understanding was exemplified in the student work, what standards were being met within the work, how teachers should lead a lesson where such examples were present, and the level of flexibility in students’ strategies. Following the discussion, the director gave the participants some time to think and then talk about the implications of their work together during the meeting.

Boundary practices in Greene tended to be similar in approach. They all tended to engage participants in using the key boundary objects—the curricular materials, the pacing guide, and the QMAs—as a way to develop approaches to instruction rooted in understanding of the mathematical content and careful attention to the nature of student thinking. Nearly all of the professional development we observed, whether it was coach professional development, leadership team professional development, MathLab, or grade-level planning meetings, engaged adults in doing mathematics problems together (usually from the Investigations curriculum) and explicitly discussing the nature of the mathematics involved in the problem. A common refrain heard from the director of mathematics when working on mathematical problems was “What is the mathematics here?” This question was, in turn, echoed by coaches who met with teachers individually, during grade-level meetings, or through professional development at each school. For example, during a coach-led professional development, the coach asked the teachers to examine specific district objectives and to consider “What is the math content . . . that students need to know to be successful with this objective?” In another example, a coach began a grade-level meeting with fifth-grade teachers by passing out teacher-generated student work and asking the teachers “What’s the math?”

Boundary practices also focused on issues of coordination and alignment, especially using the reifications to coordinate instruction with state standards and assessments. For example, coaches were encouraged to use grade-level planning meetings to examine the objectives of the pacing guides and the QMAs to focus on ways to use the curriculum to meet the state objectives as measured by the QMAs. However, coaches and leadership team members were also encouraged to work on these tasks in ways that did not lose sight of the mathematics and student learning at the center of the curriculum. The director of mathematics repeatedly emphasized using the pacing guides to link the state objectives with the particular Investigations unit as a way of focusing on the nature of the mathematics involved in the unit.

In summary, there were both similarities and differences between New York City’s and the Greene School District's architectures for learning. Both relied
on a combination of boundary practices and boundary objects, including the curriculum itself and a pacing guide. New York City’s architecture was more complex, however, because leaders had an extra level to design for: the hand off from central office to regional instructional specialists. New York City’s approach appeared to be more unidirectional and exclusive to mathematics specialists, whereas Greene’s provided opportunities for two-way influence and included the administrative line in substantive ways. Finally, while both districts attended to issues of coordination and management, Greene—more so than New York Region Z—balanced attention to coordination/management with a strong focus on mathematical content and student learning.

The Lived Local Communities

Looking across the four schools in our sample, we first identified teachers’ multiple and overlapping communities of practice using social network analysis. We then analyzed the interaction in these social networks to determine if they included the three criteria of a community of practice: shared domain, regular interaction, and shared practice. We found that most teachers in the four schools in our study were engaged in a community of practice of some form. However, the lived local communities contrasted sharply in the two districts. Teachers, coaches, and school leaders in Region Z had communities of practice that were smaller and more bounded than those in Greene. They were less likely to span the boundaries of the school and more likely to be incongruent with the focus of district reform initiatives. Perhaps most strikingly, the shared practices in Region Z tended to be focused on superficial discussion and sharing activities, while those in Greene were much more likely to be focused on in-depth discussion of student learning and the nature of mathematics.

New York City’s Region Z.—We begin our discussion with Region Z. We describe the relevant communities of practice in the two schools, paying special attention to the shared practices that define them.

Teachers Interacting with Teachers: Teachers in the two schools in Region Z had communities of practice with their colleagues that were rather bounded. At the first school—Lincoln—five out of six focal teachers had what we identified to be communities of practice with colleagues in their grade level; however only one teacher had teachers from other grade levels as part of her community of practice. While teachers’ interactions with their colleagues were overwhelmingly congruent with the reform initiative (80 percent of interactions with grade-level colleagues were congruent), their shared practices were characterized by procedural and superficial interactions. Interaction in communities of practice largely focused on managing the curriculum and keeping
pace with other colleagues in their grade. For example, one teacher explained that she talked with her colleagues about “anything that we need to cover.” Another described a recent interaction: “We compare notes and see how far we have gotten. We are generally going at the same pace, which makes me feel good that I am not either underestimating or overestimating what my students are capable of.” Overall, 37 percent of the interactions we observed or heard about were about pacing or coordinating materials. This figure is a bit misleading, however, because one teacher in Lincoln deviated from this pattern, and most of her interactions were more substantive. Without this teacher, the percentage of interactions focused on pacing and materials in this school rises to 75 percent. Only three out of five teachers reported discussing specific instructional strategies in their communities of practice; however, these discussions were largely superficial. For example, one teacher described the shared practices in his community in the following way: “You have a set of people you go to [and say] ‘I did lesson 8.5 yesterday; have you done that yet? Well, yeah. Well, how’d it go for you because my lesson went like this, like this, like this. What did you do? How did yours go?”

In Marshall, teachers’ communities of practice were more likely to involve colleagues in multiple grade levels than at Lincoln. Five out of six teachers were involved in communities of practice with grade-level colleagues, and four out of six also involved teachers in other grades at the school. Most of this interaction occurred at lunchtime and was focused on coordinating pacing. For example, one kindergarten teacher talked about a recurring conversation she had with her grade-level colleagues: “We try to sort of be on the same page throughout the year in terms of what our children are covering and what they know about math. We know what we have introduced and what we are counting when and so forth. With this program, they want you to introduce counting by twos and by fives. I have introduced counting by tens. I have introduced counting by fives, but [other teacher in grade level] hasn’t yet.” Fifty-one percent of interactions that we observed or heard about were focused on where teachers were in the textbook. There were some conversations about instructional strategies, but, as was the case in Lincoln, these conversations tended to be quite superficial. For example, a first grade teacher characterized lunchtime conversations as, “You know, we share ideas.” Another teacher said, “We just swap ideas, exchange ideas.” Some of the specific ideas that were mentioned included using food for a lesson on patterns, using “the grouchy ladybug” to teach time, and teaching children who are having difficulty with tally marks, to say “chop, chop, chop, chop, suey!” as they write the first, second, third, fourth, and fifth tally mark for representing a group of five.

It is also important to note that, as teachers in this school made meaning of the textbook in their lived communities, some came to the conclusion that
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the textbook series was inappropriate for their students or that they were better off skipping or replacing particular activities or approaches that they did not feel would work in the classroom. For example, one teacher described her interaction with her grade-level colleagues in the following way: “We agree upon a lot of things [about the curriculum]. Basically: the inconsistencies. One teacher in particular doesn’t really care much for the program at all. So we try to touch on the concepts, but not really follow it.” Another teacher explained: “To be honest with you, [my grade-level colleagues] think it blows. They don’t like it at all.” In this school, 75 percent of interactions among grade-level colleagues and 50 percent of interactions with cross-grade colleagues involved discussions about how to adjust, adapt, or ignore aspects of the curriculum in ways that were not aligned with the recommended implementation promoted by the district.

Teachers Interacting with Coaches: The coach was part of the teachers’ communities of practice for nearly all focal teachers in both schools. However, our analysis suggests that their shared practice was quite superficial. Interaction between coach and teachers focused mainly on explaining how to use the curriculum, providing materials, or giving advice about instructional strategies. For example, one teacher in Lincoln described a typical interaction with the coach in the following way:

We talked about the Math Message and the Mental Math [two components of every Everyday Mathematics lesson] and how to coordinate between the two and that we should be linking the Math Message to the initial onset of the mini-lesson [the first phase of the Workshop Model] and how those two are connected. . . . That’s something I’d like to get straight. Because the Teacher’s Guide is a bit fuzzy about that, I thought. It was a bit misleading when it came to the Math Message and the Mental Math. So, he with his training, was able to tell me that I should teach it in that sequence.

A teacher in Marshall described what she considered a typical interaction with her math coach: “I asked the math coach, I said ‘Well, David, what are we supposed to be doing [in this unit]?’ He said, ‘Well, read the manual.’” Noticeably absent from any conversations we observed, however, was meaningful discussion of mathematical content or student thinking.

Principals Interacting with Teachers and Coaches: Only two teachers in each school had a community of practice that included the principal. Even in these cases, interaction with principals was quite infrequent—one time per month at most—but quite congruent. Nearly all of the interaction we analyzed was in line with the district policy. However, interaction between principals and coaches differed in the two schools. In Lincoln, the principal reported relying on the coach for “everything related to mathematics.” The coach
reported that most of his interactions with the principal centered on two functions: identifying ahead of time the topics that the principal should expect to see when observing in classrooms and helping the principal interpret things that she had questions about. When asked for examples, the coach said, “I’d tell the principal that second grade is on ‘introducing fractions’ this week.” Overall, these conversations appeared to include limited discussion of mathematical content or student thinking. In contrast, there was little substantive interaction at all between the coach and the principal in Marshall. The coach indicated that he consulted with the principal about the math displays that were in the hallways in the school building and identified topics to be covered in after-school professional development sessions. The principal did not, however, mention the coach as someone she went to when she has a question or issue related to mathematics.

Cross-School Communities: Very few individuals in the two Region Z schools participated in communities of practice that spanned beyond the school. Only four out of the 12 focal teachers had relationships with even one person outside of the school about mathematics with enough regularity and evidence of shared practice to be considered a community of practice. Three out of the four talked with a relative about mathematics; for example, one teacher in Marshall had frequent conversations with her mother, a retired public school teacher, about the new mathematics curriculum. Two of the four talked with someone in the district office about mathematics.

The math coaches interacted frequently with coaches from other schools during biweekly coach meetings run by the district. This interaction mainly consisted of sharing strategies for working with teachers and getting advice about how to do particular units. For example, one coach described his interaction with other coaches at biweekly coach professional development in the following way: “We have the opportunity to plan for demonstration lessons. . . . We would sit as a group of coaches at a table like this and discuss a second grade lesson or a fourth grade lesson and ask for advice from other coaches and so forth.” Overall, though, coaches rarely, if ever, reached out beyond district-designed role relationships. There was little mention of informal contacts, e-mail exchanges, or any other form of on-going communication.

Greene School District.—We now turn to our second district, Greene School District. As with Region Z, we begin by describing the communities of practice that existed in the schools. We highlight the shared practices that characterize the different communities.

Teachers Interacting with Teachers: Although there were some differences within and between the two Greene schools, teachers tended to be involved in multiple, interlocking mathematics communities that were characterized by substantive conversations about mathematics. Across both Greene schools, most teachers (nine out of 12) reported that they interacted about mathematics
with teachers in multiple grade levels at their school. This is somewhat higher than teachers in Region Z, where only five out of 12 teachers had a community of practice that involved teachers in other grades. But the main difference between teachers in the Greene and Region Z schools was the practices that they shared with these colleagues. While most of the teachers’ interactions in Region Z focused on managing the curriculum and keeping pace with colleagues, these practices played less of a role in the schools in Greene. Only 22 percent of the interactions that we observed or heard about in Trafford Elementary School and 42 percent in Bakersfield Elementary School were focused on these issues (compared to 51 percent and 75 percent in the two Region Z schools). Thus, 88 percent of the interactions in Trafford, and 58 percent of those in Bakersfield, were focused on instructional strategies, student learning, and the nature of mathematics. For example, one teacher described a recent conversation with a grade-level colleague focused on student learning: “We bring some story problems that the kids are working on and really look at how their [problem solving] strategies are working and what strategies we need to maybe focus on or where we need to move the students from where they are now.” Another described a conversation that touched on the mathematical content of the lesson: “I was speaking to [another teacher] yesterday after school and I was asking her, what does it mean if they don’t understand that? It was the identity property. Zero plus one is one. What does that mean? What am I supposed to do with that? Where do I go from here? And we were determining that it’s just not appropriate for them right now.”

Finally, as was the case in Region Z, most teachers in both schools had conversations that were predominantly congruent with the intent of the curriculum. In 81 percent of the interactions we observed or heard about in Trafford and in 75 percent of the interactions in Bakersfield, teachers were making meaning of the curriculum in ways that were consistent with the approach advocated by the district.

Teachers Interacting with Coaches: Both Greene schools had two mathematics coaches, each of whom was a half-time teacher and half-time coach. These coaches played an important role in teacher communities of practice. As was the case in Region Z, nearly every teacher (11 out of 12) had one or both of the coaches as part of the community of practice around mathematics. However, the nature and frequency of these conversations varied greatly between Greene and Region Z schools. First, although there were some differences between the two Greene schools, teachers in Greene generally reported more frequent interaction with the coaches than did the teachers in Region Z. While few teachers in Region Z interacted with their coach more than one time a month, all teachers in Trafford reported meeting with their coach between two and five times a month, as did four out of five teachers in Bakersfield. Furthermore, some of this interaction occurred outside the formal
coaching structures as teachers reported reaching out to coaches informally on their own or in groups to talk about mathematics. For example, one teacher explained: “[The coach] comes in once a week and observes, . . . But she is definitely a resource that I go to all the time. I actually used her today after you left. . . . I always use my math coach, even at the end of the day when I am planning or if I get stuck and don’t know where to go or how to move my kids to the next level, I always use her for support.”

The more striking difference between Region Z and Greene, however, was the content of the coach-teacher interaction. While most coach-teacher interaction in Region Z was focused on managing the curriculum, sharing materials, and sharing instructional strategies in a superficial manner, coach-teacher interaction in the two Greene schools extended beyond these matters to include more substantive conversations about instructional strategies, the nature of student learning, and, at times, the nature of mathematics itself. For example, when asked what she talked to her coach about, one teacher in Trafford said: “I have so many kids that can’t count past six or seven, what is wrong? What am I doing wrong? That, I can take to my coaches and say: ‘Look, this is what I’ve noticed. This is what I’ve done for instruction. Do you have any advice? What do you think it might be? How can I do this or approach this differently to help these other kids that aren’t getting this concept?’”

Similarly, a teacher in Bakersfield also described the substantive nature of her conversations with her coach: “Like right now I’m still working on assessment. How can I assess while they’re working? How do I do that? And so my coach, she’s looked through articles for me. She finds articles about how to group the kids and still pull small groups. And, we’ll talk about these articles and figure out how to make that work in my classroom.”

Also, interestingly, across both schools, we found some teachers who saw their interactions with coaches as a way to influence the district. Coaches were not just seen as providing information from the district about issues of implementation but as a way to get information back up to the district. In discussing a problem that one grade-level group discovered with the quarterly assessments developed by the district, one teacher described the following:

**Interviewer:** Do you have any way of giving this feedback to the district?

**Teacher:** We do, we do. We talked to our coach, and she took it back to the—you know—her peers among other coaches. She’s actually involved in writing the next quarterly math assessment for [our grade level] at the district.

This suggests that coaches in Greene not only act as a pathway from the district to the schools but also act as a pathway from the school to the district.

Principal Interacting with Teachers and Coaches: In contrast with Re-
region Z, no teachers in Greene had interaction with principals about mathematics on a consistent and regular basis. However, also in contrast with Region Z, principals and coaches in both schools in Greene had quite robust interaction. Each school had a formal leadership team made up of principals and mathematics and literacy coaches. In both schools, this leadership team emerged as a consequential community of practice, although to a lesser extent in one of the schools. When asked who they sought out to talk with about mathematics, principals nominated coaches and coaches nominated principals. One coach described the relationship in the following way: “Generally, sometimes [the principal] will just pull us in to talk about, ‘OK, we want to do this for math’ or ‘What do you think the next direction is? She doesn’t always say, ‘Do this.’ She does ask a lot for ‘Look at our data, what do you think?’ There is a lot of that going on.” In the other school, coaches and principals visited classrooms together to observe mathematics instruction, sometimes accompanied by the district mathematics leader. After observing a classroom, the coaches and school leaders analyzed the mathematics that the lesson was addressing and discussed the degree to which the teacher’s instruction was focused on the main mathematical ideas and how students were grasping these ideas.

Cross-School Communities: Most striking in Greene is the degree to which individuals forged cross-school communities, especially coaches. When asked who they sought out to talk with about mathematics, coaches not only nominated individuals in their schools but also consistently nominated coaches at other schools and one or two people at the district level with whom they interacted on a weekly basis and with whom they had developed shared practices. Three out of the four coaches at the two schools reached beyond designed district-wide coaching meetings to contact one another on a frequent basis. As one coach said, “We spend a lot of time talking about math. I talked to [five other coaches, listed by name] about things and concerns a lot. . . . I get a lot of e-mails back and forth from them about that type of stuff, so I tend to talk to them a lot, I would say.” The coaches in Greene had rich conversations with one another about the nature of mathematics and the development of student thinking. For example, when asked to describe an example of what she talked with other coaches about, one coach provided the following:

In second grade . . . there are stringing problems, for like two plus four plus seven plus six. The kids are doing a little stringing. They call it the pull-down method. . . . So they do those, but in the third grade, when they start doing the two digit, the kids are still doing the pull-down kind of deal, but they are not keeping the place value. You see that in subtraction too. We really see it in subtraction. They are using it just like an algorithm. . . . So they are just following a different algorithm with
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really no thinking. . . . It is a misconception that in the teacher implementation of it something went haywire because the kids aren’t understanding what they’re doing. They are applying things they shouldn’t be doing. I talked to people like [coach at another school] or [second coach at another school], “What do you see at your school? Are you seeing the same thing?”

Here is another example:

We met last week in my room and I was talking. We had written down things that [a professional developer from a recent training] had said like, “We do too much about pattern and not enough about structure in mathematics.” That really spoke to me, so I asked [the other coaches] “What are you thinking about that? Tell me.” So we have more theoretical discussions. We have almost moved past, “How do you handle these people [teachers they coach]? How do you get them to do this?” We are talking about “What exactly is it the kids know and when do they know it? How do you know they know it?”

The coaches also talked a lot about specific grade-level issues (e.g., nature of mathematics in kindergarten) and could identify which coach in which school has expertise in which grade level. They also sought advice about working with particular teachers, although, as the quote above attests, by the second year of coaching, they were no longer talking about this to the same degree. As interesting perhaps is what they do not talk about: how to use the curriculum and issues of coordination and management.

Like coaches, principals also had greater cross-school interaction in Greene than in Region Z, although there was some variability between the two schools. In Trafford, the principal reported that she not only reached out and had regular conversations with multiple other principals in the district about mathematics but also was in frequent contact with at least three district leaders representing mathematics, assessment, and technology. The principal of Bakersfield—who was not as supportive of the Investigations curriculum—reported that she had frequent and on-going conversations with several principals in the district but did not interact with district mathematics leadership because “my philosophy is a little bit different [from theirs].” However, few teachers in both schools included those outside of the school as part of their communities of practice—only one teacher in Trafford and three teachers in Bakersfield did so.

In summary, there were important contrasts in the local lived communities in Region Z versus Greene. Across all four schools, coaches played a role in teachers’ lives. Yet, what was talked about in the lived encounters between
teachers and coaches differed in Region Z versus Greene. In Greene, the interactions appear to involve a mix of business/coordination issues and a focus on mathematics teaching and learning. In Region Z, in contrast, teachers’ interaction with coaches primarily focused on how to manage the Everyday Mathematics materials, gathering manipulatives and other tools for teachers, and providing general “pointers” regarding how to plan for and teach a lesson. There was little to no discussion of mathematical content or student thinking.

Teachers’ interactions with one another were less robust than teacher-coach interactions in most cases. However, interactions in teacher communities in Greene were more likely to stretch across grade levels and more likely to move beyond pacing and managing materials to also include more substantive conversations about instructional strategies, student learning, and, at times, the mathematics itself.

Another difference across Region Z and Greene was the extent to which coaches appeared to form an authentic “lived” community of practice across schools. In Greene, coaches often sought each other out outside of formal meetings; their conversations usually focused on substantive issues surrounding mathematics and how it is best taught and learned. In Region Z, we saw no evidence of this. Finally, Greene and Region Z also differed with respect to the extent to which principals were an important part of various lived communities. In both Greene and Region Z, we saw little evidence of teachers interacting with principals around mathematics; rather administrators in both systems appeared to engage with the mathematics reform through their interactions with the mathematics coaches. However, the nature of principal-coach interactions differed substantially. In Greene, coaches and principals took on substantive issues related to how best to carry out mathematics reform in their various schools; in Region Z the relationship was defined by a division of responsibility with the principal turning over the math program to the coach.

Finally, as noted earlier, the connections forged between districts and schools appeared to be more unidirectional in Region Z, where principals and coaches rarely reached out beyond district-designated role relationships. In Greene, however, coaches and principals not only were more tightly connected to each other but also reached out to district leadership more frequently and in a variety of ways. In the previous section, we noted that coaches working to help design pacing schedules and the QMA could be viewed as the shaping of district policy. In this section, we see one of the two principals engaging in frequent district-level interactions with leaders of mathematics, assessment, and technology. In so doing, the Greene coaches and principals can be seen as having the opportunity to shape district direction as opposed to being recipients of district mandates.
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Summary and Implications

The purpose of this article was to investigate and elaborate the conditions that districts design to support teachers' opportunities to learn in response to district-initiated reforms. More specifically, we used community of practice theory to probe the mechanisms that districts designed to connect various communities—which we call the districts' architectures for learning—and the manner in which those mechanisms mediated teachers' interactions in their local communities. The two districts had architectures for learning that differed with respect to structure and nature of engagement; these differences, in turn, were associated with dissimilar opportunities for teachers to learn.

From the structural perspective, Region Z's architecture was unidirectional while Greene's was bidirectional. In particular, the Greene coaches and the principals interacted more frequently and in more substantive ways with one another and with district leadership than did the Region Z coaches and principals. The Greene principals and coaches who interacted with district leaders can be viewed as brokers, individuals who help to coordinate practices across communities. In this case, by bringing information about, and practices from, classrooms up into district-level communities, coaches and principals created new possibilities for learning among district staff about how best to support meaningful opportunities for teacher learning that would be aligned with district designs. Alignment efforts in New York City, on the other hand, seemed to be focused on top-down compliance, not mutual influence. Region Z was associated with teacher-teacher interactions that—although congruent with district directions—focused primarily on procedures, many of which can be viewed as methods of "marking compliance" (e.g., being at the right lesson at the right time according to the pacing guide) as opposed to underlying mathematical understandings. The Greene teachers' interactions, in contrast, included much more attention to the substance of mathematics and to how children learned mathematics.

Another structural difference between the two districts' architectures for learning was their inclusivity, with Greene's reaching out to include administrative staff and Region Z's staying within the silo of mathematics. In Greene, school-level administrators were knowledgeable participants in discussions about the mathematics program, as revealed by robust interactions between the coaches and school leaders surrounding critical decisions that lay at the core of mathematics instruction: the direction of the program, how data on student learning might suggest a next step, and so forth. In New York City, however, principals interacted with coaches about mathematics in superficial ways, such as deciding how mathematics work should be displayed in the hallways; they seldom participated in core decisions surrounding the professional development or implementation of the new curriculum. Not surprisingly,
the New York City principals appeared at times to not highly value the mathematics program, as when, for example, they complained about the time staff spent out of the building for math-related training or when they tapped their math coaches to do nonmathematics work in the school. In Greene, by contrast, there were explicit discussions within the school leadership team about the necessity of keeping the math coach role focused on teaching and learning in mathematics.

Despite these differences in the structural aspects of the two districts’ architectures for learning, our analysis of the “lived communities” revealed that, for the most part, teachers’ interactions surrounding implementation of the mathematics programs were congruent with district guidelines in both districts. On one level, our findings could be interpreted as indicating that the direction or inclusivity of the connecting mechanisms does not matter with respect to attaining congruence with the district program in teachers’ communities. Indeed, we argue that many studies of alignment start and stop at this level of analysis. However, looking beyond these structural attributes, we found that the nature of the engagement that occurred in the two districts’ boundary practices was quite different and that this difference appeared to be connected to qualitatively different opportunities to learn within the teacher communities in Greene versus Region Z.

More specifically, the two districts differed with respect to the extent to which their architectures for learning were centered on procedural concerns versus the teaching and learning of mathematics. Returning to Wenger’s central premise regarding the kinds of learning that are inspired under different forms of alignment, we propose that the differences between Region Z and Greene in this regard can be explained by differences in how they integrated reification and participation. In New York City, both the architectural design for learning and the interactions in the lived communities relied a great deal on heavily specified boundary objects; the participation surrounding those boundary objects was focused on issues of coordination and management, not issues of teaching and learning mathematics. In Greene, the boundary objects also commanded attention, but they did so as foci around which more teaching-and-learning centered negotiations occurred.

When discussing designs for learning, Wenger (1998) contends that different reifications provide different affordances for the negotiation of meaning (Wenger 1998, 232). All designers, he argues, must confront decisions regarding what to reify, when, and in what form. Designers also have to make decisions surrounding participation. These involve getting the right people in the right place at the right time and in the right relation to one another and to key reifications. The challenge for design is to not overly reify, that is, to not specify so much in advance that there is little room for participants to design aspects of their own learning. Rather than doing away with such “emergent” aspects
of design, the trick, according to Wenger, is to include them, to anticipate them and see them as opportunities for meaningful learning. This approach to design can be contrasted with front-loading a heavy dose of specificity. Such highly specified designs, Wenger argues, come with a certain amount of rigidity, rigidity that can actually work against individuals redesigning for the particular case with which they are confronted.

The two key boundary objects with which Greene and Region Z were working were very different in this regard. Investigations provides a set of open-ended activities for teachers and students to engage in, along with information about the big mathematical ideas at play in the activities and ways in which students might respond to those activities. However, it does not script the teaching and learning that should occur, believing that learning is always an emergent phenomenon, one that teachers must be attuned to through their attention to student thinking (Russell et al. 1998). Thus, while helping teachers to anticipate what students might do and need, the Investigations curriculum does not specify a specific teaching and learning route to follow. Moreover, by identifying the big mathematical idea at play (and even providing a brief tutorial on it), the materials allow teachers to apprehend the purpose of the activities; armed with this knowledge and information about possible student responses, there is the possibility that, with the right support, they can become “designers of instruction.”

Everyday Mathematics, on the other hand, is divided into a series of daily lessons, each of which teaches to a fairly narrow objective. The tasks are much less open-ended than Investigations tasks and tend to channel students and teachers toward a particular route through the problem. Teachers are provided with few in-depth details regarding how students might be expected to respond to the problems. There is, however, very detailed guidance on how to set up activities, what questions to ask, and what problems to give for reinforcement and follow-up. In general, however, there is little room for learning as an emergent phenomenon.

This suggests that the nature of the boundary objects used by district leaders matters. Some boundary objects provide multiple openings for the negotiation of meaning while others provide fewer. Accordingly, when designing for participation surrounding one’s selected boundary objects, district leaders may be constrained by what a particular reification affords. As such, we propose that another explanation for the differences observed in Region Z and Greene was the nature of the boundary objects that served as points of focus for the negotiation of meaning within the boundary practices. Everyday Mathematics provided fewer openings for RISs, coaches, principal, or teachers to negotiate the meaning that the reform would have for their practices. As such, their participation—be it within or between communities—was often characterized by figuring out the “right way to do it” and how to coordinate the nonne-
gotiables of teaching the curriculum with other teaching tasks (e.g., report cards and assessments).

Investigations, in contrast, provided ample openings for individuals to negotiate meaning both within and across communities. For district leaders and coaches, the curriculum provided many rich tasks that served as fodder for engaging teachers in mathematics teaching and learning during boundary practices. For teachers, the curriculum provided many opportunities to negotiate meaning about the very thing for which they are responsible and arguably care most about: the design of teaching and learning in their own classroom. Thus, in Greene, participation was richer, focusing on the concepts that students were learning and how they were learning them. This kind of participation, according to Wenger, is more desirable because it allows teachers to adjust their practice when confronted with particular classroom and student scenarios.

In sum, reification and participation are two complementary aspects of design that create two kinds of affordances for aligned learning (Wenger 1998, 231): (a) getting boundary objects in place so that practice at various levels has to be organized around them; and (b) getting the right people to interact to make something happen. Designs (or architectures) for learning are not recipes: they cannot infallibly produce learning that is aligned across an organization. Rather, Wenger argues, architectures for learning represent a set of choices surrounding the distribution of reification and participation. Good designs, we argue, are those that strike a balance between reification and participation—a balance that allows for negotiation of meaning surrounding features of practice about which participants care and are knowledgeable while still keeping the entire organization moving toward shared, recognizable goals.

What lessons do these analyses offer for policy makers and others who are interested in enhancing the district’s role in instructional improvement? If one agrees with the growing consensus that the problem of reform is a problem of teacher learning, this comparative analysis suggests that teachers’ opportunities to learn are mediated by the structure and nature of cross-community interaction as designed by the district. While alignment is important, how alignment is achieved may be more important in terms of the kinds of opportunities for teacher learning that are created. Individuals’ opportunities to learn are shaped by how meanings are negotiated surrounding particular boundary objects. Hence, designers must create or select boundary objects with this negotiation in mind. More specifically, district leaders need to plan for the various forms of participation that boundary objects might elicit as they make their way across the boundaries of different communities.

Finally, one could ask the question: Alignment between and among whom? We have shown that informal communities can differ from formal organizational designations. Yet, most leaders design learning activities with formally
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designated groups in mind (e.g., principals will do X; grade-level teams will do Y). Our study suggests that leaders might do well to recognize that communities form of their own volition and that taking advantage of existing communities might be an option. For example, the district leaders in Greene were able to build on a previous positive history of mathematics communities of practice. The interschool coaching community referred to earlier was actually built prior to the relatively recent efforts to scale-up the new curriculum. A core group of veteran teachers in the district participated in 180 hours of professional development on Cognitively Guided Instruction through an Urban Systemic Initiative grant. Those teachers developed a community united in talking deeply about mathematics, especially mathematical content. Many of these teachers were then tapped first to serve on the adoption committee and then to serve as coaches in their schools. So it appears that rather than designed structures for professional development encouraging the development of a lived community, the designed community tapped into and extended a preexisting community. This suggests that levers for instructional improvement might be located in places that leaders are not necessarily predisposed to look. By scanning their districts with an eye toward “structures of participation” rather than formally designated role groups, leaders can be better positioned to support opportunities for learning—not only by creating new communities but also by identifying and building on groups with a shared history.
Appendix A

TABLE A1

Demographic Characteristics of Case Study Schools

<table>
<thead>
<tr>
<th>School</th>
<th>No. Students</th>
<th>Race/Ethnicity of Students</th>
<th>Free/Reduced Lunch (%)</th>
<th>English-Language Learners (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region Z: Lincoln 523</td>
<td>African American (64%), Hispanic (33%), White (1%), Native American (1%), Asian (1%)</td>
<td>86</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Marshall 435</td>
<td>African American (52%), Hispanic (47%), White (1%), Asian (1%)</td>
<td>83</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Greene: Trafford 914</td>
<td>African American (3%), Hispanic (89%), Native American (2%), White (6%)</td>
<td>93</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Bakersfield 644</td>
<td>African American (5%), Hispanic (89%), White (5%), Native American (1%)</td>
<td>99</td>
<td>52</td>
<td></td>
</tr>
</tbody>
</table>

Appendix B

Teacher Protocol–Social Network Questions (Similar Questions Were Asked of Coaches and Principals)

*Introductory script:* One of the things we’re interested in learning about is how teachers talk with one another about mathematics instruction and how that makes a difference—or not—in what they do in their classroom.

*Informal social network:*

1. Since the beginning of the school year, have you gone to anyone for advice, with a question or concern, or just to talk something through about mathematics instruction? If so, who, have you gone to? Who else have you gone to? Anyone else inside or outside of school?
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2. For each person mentioned, ask the following set of questions (go through complete set of questions for each person mentioned in turn):
   - [if not mentioned] What role does that person play? [are they a teacher? What grade? Something else?]
   - How frequently have you talked with this person around mathematics?
   - What kinds of things did you talk about?
   - Probe:
     - particular teaching challenges;
     - problems with specific students;
     - strategizing about using the curriculum: sharing materials and instructional approaches;
     - creating materials and instructional approaches
     - coordinating instruction with one another
   - What advice, information did they offer? Can you give me an example? [to get at content of conversation]
   - How did you respond to this advice? How, if at all, did this advice/information influence your mathematics teaching? Can you give me an example?

3. Why do you go to some people and not others to talk about mathematics instruction? [probe:
   - trust,
   - personal relationship/closeness,
   - attributions of expertise,
   - authority relations (I was required to go to her),
   - anticipation of exchange relationship (I help her so she’ll help me)

Interaction in formal settings:

4. What structured opportunities, if any, do teachers have in this school to meet with one another? [probe: whole school meetings, grade level, committees, leadership teams, etc.]
   - When and how often do each of these venues meet?
   - Who do you work with in these settings?
   - What kinds of things do you do in each of these meetings [probe: nature of tasks]?
   - How, if at all, does participation in any of these meetings influence your mathematics instruction?

Notes

This work was supported from a grant from the National Science Foundation (IERI Grant REC-0228343). The content or opinions expressed herein do not necessarily reflect the views of the National Science Foundation or any other agency of the U.S. Government. The authors are grateful to the teachers, coaches, and administrators in the New York City Public Schools (esp. Region Z) and the Greene School District. They also thank the members of the IERI research team who participated in the collection and organization of data reported here, including Stephanie Sutherland, Kellie Glanz, Teresa McCaffrey, Chris Nelson, Jennifer Russell, Marcia Seeley, Jaime Smith, Sarah Spencer, and Mikyung Wolf.

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1. Existing research on teacher professional community also tends to assume that interaction in communities is always positive and supports reform implementation. However, several studies provide evidence that collegial interactions can reinforce norms of privacy and existing instructional practices (Achinstein 2002; Little 1982, 1990) or become “contrived collegiality” as teachers are invited or required to collaborate but on agendas set by others (Hargreaves 1991). Furthermore, communities can have strong negative consequences, such as exclusion of outsiders, excess claims on group members, restrictions of individual freedoms, and downward leveling norms (Portes 1998). All of this suggests that it is important not to romanticize community as an outcome but rather to empirically investigate the consequences of community for such things as opportunities for learning, change in practices, and implementation of reform.

2. In so doing, we add to the growing literature in education that aims to understand how communities provide opportunities for teacher learning (Cobb 2003; Coburn and Stein 2006; Franke and Kazemi 2001; Gallucci 2003; Little 2003; Stein and Brown 1997; Stein et al. 1998).

3. Of course, it is also possible to think of alignment in terms of the way that districts align to schools’ goals, as suggested by Honig (2004). However, since the focus of this article is on the role of communities of practice in districts’ efforts to scale up instructional reform, we focus primarily on how schools align to district goals, although we pay careful attention to the mechanisms by which schools are able to influence district goals.

4. The names of both districts and all schools are pseudonyms.

5. Some Greene teachers used selected modules of Investigations during the 2002–3 school year; Summer 2003, however, marked the beginning of comprehensive implementation.

6. This adoption followed the appointment of Joel Klein as chancellor and the reorganization of the district into 10 regions.

7. The larger study from which these data were drawn was primarily concerned with the implementation of mathematics reform in high-poverty schools. Therefore, we attempted to hold poverty level fairly constant so that we could examine how the nature of teachers’ communities of practice unfolds in schools with similar challenges of high poverty. Future research is needed to investigate the degree to which the nature of interaction in teacher professional communities might differ in schools with different racial and linguistic groups.

8. Research by Spillane (2005) provides evidence that teachers’ social networks can vary substantially by subject matter. For this reason, we specifically asked about teachers’ ties in mathematics rather than asking who they interacted with more generally.

9. Wenger et al. (1998) also discuss the “knowledge generation” function of communities of practice, perhaps because this particular publication is oriented toward the business world where “managing knowledge” and the “knowledge economy” has resonance. We have elected not to focus specifically on this function, preferring to characterize all work-oriented interactions as potential sites for learning.

10. We reasoned that routines that were shared across members of a community of practice would be the same routines that one would expect to see across events. That is, if a teacher community shares the practice of working on math problems together, you would expect to see all members participating—at some level—in that practice. You would also expect to see the practice on multiple occasions. Routines that show up infrequently would suggest idiosyncratic rather than shared practice.

11. High professional community schools did vary from low professional community schools in a given district in the size of teachers’, coaches’, and principals’ social networks and, to a lesser extent, the degree to which those ties spanned beyond grade
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level, included the principal, and spanned outside of schools. (Teachers in high professional community schools were more likely to have slightly larger and more varied social networks.) However, these schools were more similar within district than between districts on the more substantive dimensions of frequency and intensity of connections, congruence, and nature of interaction.

12. We are mindful of the fact that these are role groups designated by organizational leaders, which may or may not coincide with the informal communities that individuals chose to opt into.

13. There were also regional teacher training events, but they happened infrequently and involved a small subset of the teachers.

14. The CAB began with a brief introduction to the district’s instructional approach. The remainder of this thick, two-volume, three-ringed binder was arranged by grade level and by lesson. For each day, it specified the lesson (page numbers in Everyday Mathematics), the mathematical focus of the lesson, where the lesson fell in terms of monthly pacing guidelines, student workbook pages for in-class work, homework pages from a supplemental curriculum called Math Steps, and how the lesson was aligned with the city scope and sequence and with the state standards.

15. The New York City system had made some provisions for mathematics training for principals and assistant principals. We observed two of these sessions, both of which were poorly attended and were run by individuals who were not deeply familiar with the philosophy or procedures of Everyday Mathematics use in the New York City system.

16. For example, in the very first Ris meeting (October 3), participants were given 12 student responses to an Everyday Mathematics problem and asked to group them in a way that made sense. In the subsequent meeting, Ris again examined student work and then viewed a videotape of the lesson within which that work was produced.

17. Math Lab (which occurred during breaks between semesters) involved teams of teachers teaching children in the morning using Investigations materials and then having professional development with coaches in the afternoon that helped them deepen their understanding of the curriculum and the mathematics that lies beneath it.

18. The structure of coaching varied somewhat school by school. Most schools had coaches coaching individual teachers, including modeling lessons, watching teachers teach, and facilitating reflective conversations, and action planning. Some schools also had coaches meet with grade-level teams once a week. Their role in these grade-level teams varied from providing information, to leading discussions on “how things went,” to more structured activities like joint planning, common lessons, or looking jointly at student work.

19. Wood and Talbert (2007) refer to such individuals as “knowledge activists,” individuals who spur reciprocal communication and joint work across layers of the district.

20. An interesting discrepancy in the data occurred in Marshall, where the teachers openly discussed ways to adjust, adapt, or ignore aspects of Everyday Mathematics in ways that were not congruent with the recommended implementation promoted by the district; yet nearly all of the teachers who interacted with the principal regularly did so in a way that was aligned with district directions, suggesting that “showing” alignment was an understood part of the game.

21. Both curricula are standards based and teach for conceptual understanding, not simply procedural competence. However, they do so in different ways.

22. See Stein and Kim (forthcoming) for an analysis of the differences between the two curricula in terms of the learning demands and opportunities that they provide for teachers.

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AUGUST 2008
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