
FOCUS ARTICLE

Research on Data Use: A Framework and Analysis

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One of the central lessons from research on data use in schools and school districts is that assessments, student tests, and other forms of data are only as good as how they are used. But what influences how they are used? This relatively straightforward question turns out to be fairly complex to answer. Data use implicates a number of processes, conditions, and contexts. It involves interpretive processes, as using data requires that the user interpret the data and construct implications for next steps. It implicates social and organizational conditions, since the data use unfolds in the context of a multileveled organizational system. And, because data can be a source of power, particularly in the current accountability environment, data use also involves power relations. In this article, we put forward a framework for understanding the phenomenon of data use in the context of data use interventions. We draw on existing research and theory to identify key dimensions of data use that we should attend to and offer a way to understand how these dimensions might interact. In so doing, we provide guidance for studying the pathways between data use interventions and various outcomes of value.

Keywords: conceptual framework, data use, interpretation, power, social context, social interaction

One of the central lessons from research on data use in schools and school districts is that assessments, student tests, and other forms of data are only as good as how they are used. But what influences how they are used? Existing research on data use points to a broad array of dimensions that matter for how data use unfolds, ranging from individual factors such as beliefs and

knowledge to organizational and even political ones. To complicate matters further, assessments and test scores are rarely used in isolation. Increasingly, they arrive in schools as part of multipronged interventions promoting data use and data driven decision making (Young & Kim, 2010). These interventions vary in scope and complexity, from the provision of professional development to accompany a new assessment, on the one hand, to comprehensive initiatives, on the other, that include new assessments, new technology for organizing and displaying results, the institution of regular data conversations structured by protocols and guided by facilitation, and rewards and sanctions for performance.

In this article, we put forward a framework for understanding the phenomenon of data use in the context of data use interventions. Our goal is to provide a way to understand how pieces of the data use puzzle fit together in order to better illuminate what is involved in data use and provide conceptual guidance for how we might study it. To that end, we identify key dimensions of data use that should be attended to and offer a way to understand how these dimensions might interact. Our framework acknowledges that data use implicates a number of processes, conditions, and contexts. It involves interpretive processes, as using data requires that the user interpret the data and construct implications for next steps (Coburn, Toure, & Yamashita, 2009; Moss, 2007; Spillane & Miele, 2007). It implicates social and organizational conditions, since the data use unfolds in the context of a multileveled organizational system called public schools, which enable and constrain the dynamics of interpretation and action (Honig & Venkateswaran, *in press*; Little, *in press*; Spillane, *in press*). And, because data is so often tightly intertwined with power, particularly in the current accountability environment, data use involves power and politics as well (Coburn, Honig, & Stein, 2009; Henig, *in press*; Stone, 2002).

To build the framework, we draw on existing research and theory to describe the underlying interpretive processes that link data to action and discuss the interrelated organizational and political contexts within which these processes unfold.¹ We then show how data use interventions interact with these contexts to shape the underlying data use processes in ways that have consequences for student learning and other outcomes. In so doing, we provide guidance for studying the potential pathways between data use interventions and various outcomes of value. And, we

¹This article is meant to be a conceptual essay, not a comprehensive literature review. However, we did review a great deal of research on data use. We were aided in our efforts to identify relevant literature by the fact that the production of this essay happened in the context of a series of meetings sponsored by the Spencer Foundation that sought to characterize the existing research base on data use. As part of this initiative, the Spencer Foundation commissioned comprehensive literature reviews by 15 scholars on different aspects of the data use puzzle. We drew on these literature reviews (especially, Henig, *in press*; Honig & Venkateswaran, *in press*; Jennings, *in press*; Koretz & Jennings, 2010; Little, *in press*; Marsh, *in press*; Spillane, *in press*; and Supovitz, 2011), as well as a comprehensive literature review we had recently completed ourselves on data use at the district level (Coburn, Honig, & Stein, 2009) as a starting point. We read and reviewed articles identified by these manuscripts, as well as additional articles found in the reference lists of the articles we read. We also read and reviewed several recent edited volumes on data use (Bransford, Stipek, Vye, Gomez, & Lam, 2009; Earl & Timperley, 2009; Kowalki & Lasley, 2009; Mandinach & Honey, 2008; Moss, 2007) as well as a recent comprehensive review commissioned by the Institute for Education Sciences (Hamilton et al., 2009). These volumes were sources of scholarship on data use to review, and their reference lists provided insight into further resources to pursue. All told, we read and reviewed 161 articles, books, book chapters, and reports. However, while our review of the research was extensive, we do not claim that it was comprehensive. Indeed, it is possible that we missed some articles, especially given the burgeoning interest in this topic. Therefore, claims that we make about the state of the research literature on data use should be viewed with caution.

seek to stimulate discussion between the different research communities that must work together if we are to develop new knowledge in this area.

We begin by providing an overview of our framework. In subsequent sections, we discuss each component of the framework in greater depth, describing the research and theory upon which it is based. We close by discussing the implications of this framework for future research.

ORGANIZING THE RESEARCH ON DATA USE: A FRAMEWORK

As data use interventions have proliferated across the country, so too has research on data use. Yet, the research base is somewhat disorganized. Researchers from disparate traditions focus on different aspects of the data use phenomenon. They draw on different concepts and language, sometimes to discuss the same thing. And, they do not always reach out across disciplinary boundaries and research communities to attend to findings from those in other traditions. As a result, the growing body of research has identified a large number of factors that influence data use (see, for example, recent reviews by Jennings, in press; Marsh, in press; Henig, in press; Honig & Venkateswaran, in press), but provides limited guidance about how these factors interact. Thus, we know relatively little about the pathways between data use interventions and outcomes.

Here, we take a first step in addressing this state of affairs. We put forward a framework for organizing research on data use. The framework, depicted in Figure 1, is intended to identify key dimensions that we should attend to if we want to understand the process and outcomes of data use in the context of data use interventions, and provide a way to understand how these dimensions might interact. We discuss the framework in 2 parts. In this section, we provide a broad overview of the major components of the framework. We then provide details on each component in subsequent sections of the article.

At the center of our framework is the *process of data use*. We define the process of data use as what actually happens when individuals interact with assessments, test scores, and other forms of data in the course of their ongoing work.² Existing research in cognitive and social psychology suggests that data use is, at the root, an interpretive process that involves noticing data in the first place, making meaning of it, and constructing implications for action. The process is fundamentally interactive, influenced by characteristics of the individuals involved and the dynamics of the social interaction. Throughout our discussion, we are interested in the full range of data users—not only teachers but also school leaders and district administrators. Data use is a multilevel phenomenon in education. In order to understand how data use unfolds, it is important to investigate the process as experienced individuals at multiple levels of the system.

The process of data use is shaped in significant ways by the *organizational and political context* of schools and districts, represented by the outer circle in Figure 1. We identify key dimensions of context that span from proximal to distal. At the most proximal level, data use routines structure who teachers and others interact with, around what data, in what ways. These routines are influenced by the configuration of time, access to data, and organizational and

²In other work, we have referred to this construct as “the practice of data use” (Coburn & Turner, in press). Here, we refer to it as “the process of data use” to help distinguish individuals’ engagement with data from the change in practice that may result.

Interventions to promote data use

- tools
- comprehensive data initiatives
- accountability policy

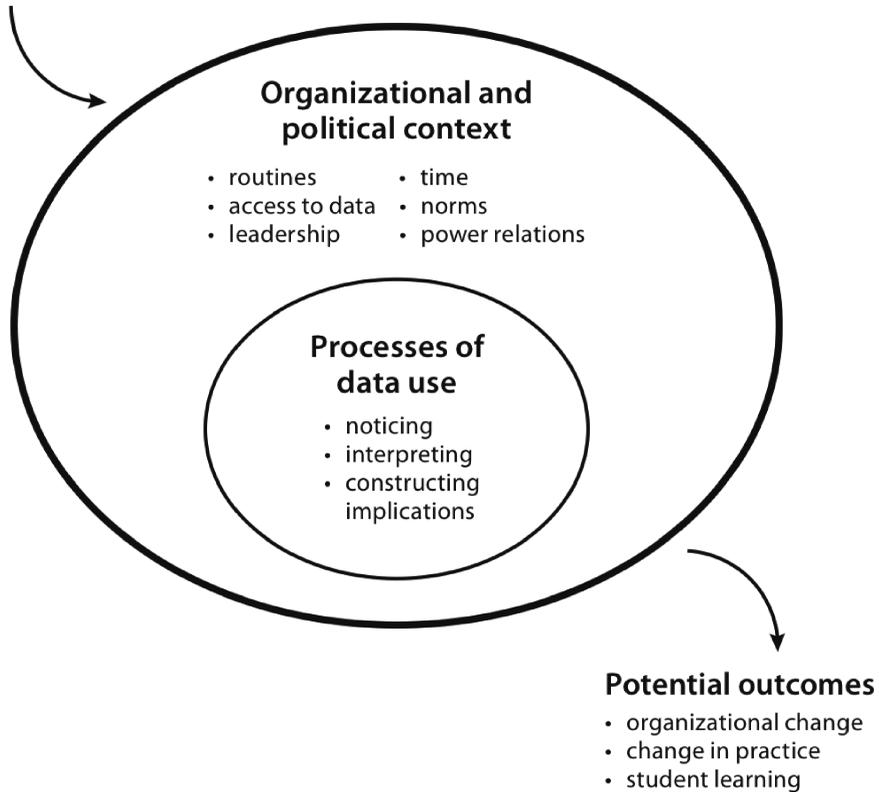


FIGURE 1 Framework for data use.

occupational norms that guide interaction. Leadership plays a role in all these organizational dimensions. Finally, these dimensions of context are intertwined and influenced by relations of power and authority.

Interventions to promote data use interact with dimensions of the organizational and political context as they attempt to alter teachers', school leaders', or district leaders' use of data in their on-going work.³ As shown at the top left of Figure 1, we identify 3 categories of interventions: (a) tools to promote data use, such as protocols for data analysis, processes for collecting observational data, and formative assessment systems; (b) comprehensive data initiatives that bring together multiple tools, processes, and technology and strive for systemic improvement; and (c)

³In focusing on data use interventions, this article focuses on planned or intentional change efforts. We acknowledge, however, that some data use may be unplanned or emergent.

high-profile policy initiatives that promote data use, most notably state and federal accountability policies. Features of these interventions interact with contexts and shape the process of data use.

The final component of the framework is *potential outcomes*, represented at the bottom right of Figure 1. Advocates promoting data use tout a number of benefits that schools and school districts will realize if they engage in data use activities. Researchers, in turn, investigate the impact of data processes and data interventions on a similarly wide range of outcomes. Here, we identify 3 potentially interrelated outcomes of data use: (a) outcomes related to student learning; (b) those related to changes in teacher and administrative practice; and, (c) those related to organizational or systemic change.

In the text below, we discuss each component of the framework in more detail. We draw on existing research and theory to provide definitions of the key dimensions we discuss and suggest ways to understand the connections between them. In so doing, we begin to outline potential pathways between intervention and outcomes. We close with a discussion of the implications of our analysis for future research on data use.

THE PROCESS OF DATA USE

One of the main lessons from research on the process of data use is the central role of interpretation. Data does not speak for itself. Rather, people must actively make meaning of the data and construct implications for action. In order to understand how test scores, assessments, and other forms of data are used, it is necessary to understand these interpretative processes. In this section, we turn to the center of Figure 1 to investigate what we know about data use processes. We ask, What is the nature of data use processes?

We argue that interpretation is a central part of the data use process, playing a role in how individuals notice data in the first place, how they make meaning of it, and how they come to understandings about the implications of the data for action. It is these understandings about implications for action that, once deliberated and debated, guide decision making and action. Interpretive processes—*noticing, interpreting, and constructing implications for action*—are shaped by individual beliefs, knowledge, and motivation and are influenced by the nature and patterns of social interaction.

Noticing, Interpreting, and Constructing Implications for Action

The process of data use, and the role of interpretation, begins as individuals or groups *notice* the data or patterns in the data in the first place. Existing research suggests that individuals routinely fail to attend to key pieces of information or major patterns in data. Attention is partial and filtered in significant ways (Spillane & Miele, 2007). People tend to search for and see aspects of the data that support their beliefs, assumptions, and experiences and do not even notice data that might contradict or challenge these beliefs (Bickel & Cooley, 1985; David, 1981; Hannaway, 1989; Ingram, Louis, & Schroeder, 2004; Kennedy, 1982; Young & Kim, 2010). This phenomenon may be exacerbated during conditions of data overload that many schools and districts are currently experiencing. Under these conditions, individuals often narrow the range of information they search for and pay attention to because they simply cannot attend to it all given real limits of their time and attention (Honig, 2003).

But noticing data is only a first step. Individuals must also *interpret* the test scores or assessment results; that is, they must construct an understanding of what the data mean. Is the test score high or low? What is the evidence of student learning represented in the work? To what do we attribute this performance? Is the data, assessment, or test score valid? Individuals make these interpretations by fitting new information into preexisting beliefs or cognitive frameworks (Spillane & Miele, 2007; Weick, 1995). New information is always understood through the lens of what we already know and believe (Greeno, Collins, & Resnick, 1996), influencing how data is encoded, organized, and interpreted (Spillane & Miele, 2007). Cognitive psychologists remind us that it is far more likely that we will assimilate information into pre-existing ways of seeing the world than engage with data in ways that cause us to reconfigure or “accommodate” existing cognitive frameworks in light of new information (see Spillane & Miele, 2007, for a review of this literature). Indeed, there are ample instances in the research on data use where individuals interpret test scores or assessments as confirming pre-existing beliefs and discounting the data when they challenge these beliefs (Coburn, 2001; Coburn et al., 2009; David, 1981; Young & Kim, 2010). For example, in her study of the use of Title I evaluations in 15 districts, David (1981) found that district administrators consistently discounted evaluations that challenged their perceptions of the programs, questioning their validity, the appropriateness of the methodology and measures, and the degree to which the evaluations measured valued outcomes.

Interpretive processes are also front and center as individuals *construct implications for action*. When teachers decide the implication of the data is that they should modify their instruction, regroup students based on assessments, or not change anything because the problem has to do with the construction of the test or children’s home life, interpretation plays a central role. When school or district administrators decide the data imply that they should allocate resources in a new way, develop new policies or programs, or maintain current course of action, interpretation also plays a central role. In connecting the data with a response, individuals link together a series of premises into an argument for a particular direction to pursue (Phillips, 2007). Bridging the space between data and a response involves a series of assumptions, conjectures, and judgments (Coburn et al., 2009; Kennedy, 1982; Phillips, 2007). These assumptions and judgments tend to be rooted in one’s prior beliefs and experiences. For example, in a longitudinal study of data use at the district central office, Coburn and colleagues (2009) found that those in the district who had beliefs about mathematics consistent with the standards-based curriculum attributed low test scores to lack of professional development for teachers and argued for increased resources for teacher professional development. Those in the district who favored more traditional approaches to mathematics instruction attributed the low test scores to a lack of attention to basic skills in the curriculum and argued that the district should adopt a supplementary curriculum to provide students practice with math facts. It is individuals’ construction of implications for action that then informs what they do in response to data. These implications also become fodder for deliberation, negotiation, and debate at the heart of decision making.

Beliefs, Knowledge, and Motivation

As should be clear from the foregoing discussion, individuals’ *beliefs* play an important role in data use processes. There is quite a bit of evidence that beliefs play a central role in noticing data (Bickel & Cooley, 1985; David, 1981; Hannaway, 1989; Kennedy, 1982, 1984; West & Rhoton, 1994), interpreting data (Bickel & Cooley, 1985; Coburn et al., 2009; Cromey, 2000; David,

1981; Hallett, 2010; Herman & Gribbons, 2001; Ikemoto & Marsh, 2007; Ingram et al., 2004; Kerr Marsh, Ikemoto, & Barney, 2006; Mintrop, 2004; Young & Kim, 2010), and in constructing implications for action (Coburn et al., 2009; Kennedy, 1982; Spillane, in press). For example, teachers often perceive standardized test data or interim assessments as lacking either validity or usefulness for making decisions about student learning or teacher effectiveness. These beliefs shape what data teachers seek out and notice when they make instructional decisions, for example, attending more closely to student work or student behavior as indicators of student learning (Cromey, 2000; Ingram et al., 2004; Kerr et al., 2006).

Knowledge may also play a role. Teachers' and district leaders' interpretation of data can be problematic when they lack substantive *knowledge* of the subject matter relevant to the decision (Coburn et al., 2009; Hubbard, 2010; Little, in press; Little & Curry, 2009; Timperley, 2009). For example, in a study of 7 schools involved in a major reading initiative, Timperley (2009) analyzed transcripts of teachers' data meetings and found that teachers lacked sufficient pedagogical content knowledge to draw strong inferences from test score data and identify potential instructional choices in a rigorous way. Knowledge of data analysis is also important, as it has the potential to help data users identify needed data and draw inferences with data in appropriate ways. Yet many researchers report that teachers, school administrators, and others have limited knowledge of the mechanics of data analysis, including how to ask questions, select data to answer these questions, use technology to manipulate data, and draw valid interpretations of the data (Cromey, 2000; Feldman & Tung, 2001; Kerr et al., 2006; Mason, 2002; Marsh, Pane, & Hamilton, 2006; Means, Padilla, DeBarger, & Bakia, 2009; Supovitz & Klein, 2003).

Finally, theoretical work suggests that *motivation* influences how individuals engage with and interpret data use. Research in psychology suggests that individuals have strong motivation to maintain a positive self-image. This self-affirmation bias may lead to a tendency to discount evidence that raises questions about the efficacy of past practices or performance. At the same time, Edwards and Smith (1975) argue that motivation to reach certain goals may lead to greater efforts to puzzle through undesirable evidence, rather than the more typical response of discounting it (as cited in Spillane, Reiser, & Reimer, 2002). In his now-classic study, Lortie (1975) argues that teachers' inclination to attend selectively to evidence of effectiveness (for example, the turn-around student) rather than whole-class patterns enables teachers to preserve the "psychic rewards" of teaching.

Social Interaction

Finally, data use in schools and school systems is rarely an individual endeavor. Rather, it tends to happen in social interaction and negotiation with colleagues (Halverson, Grigg, Prichett, & Thomas, 2007; Means, Gallagher, & Padilla, 2007; Means et al., 2009; Spillane, in press). Even teachers, who typically work alone in their classrooms, interact with children, their colleagues, and coaches and school leaders around data in ongoing ways. This means that interpretive processes—noticing data, interpreting it, and constructing implications for action—are typically influenced by interaction and negotiation with others.

Who one interacts with matters. Individuals come to the table with a variety of beliefs, knowledge, or motivations (Coburn & Talbert, 2006; Coburn et al., 2009; Spillane, in press). They also bring different ideas and information to inform deliberation and debate (Honig, Copland, Rainey, Lorton, & Newton, 2010). While interactions may lead to the development of shared understandings (Kennedy, 1982), groups made up of individuals with contrasting beliefs and

knowledge can also notice different data (Spillane, *in press*), come to different interpretations of the same data (Coburn, 2001; Coburn et al., 2009; Hallett, 2010), or construct different implications for action (Coburn et al., 2009; Spillane, *in press*). For example, Spillane (*in press*) draws on data on principal-teacher interaction in elementary schools in Chicago to demonstrate how the principal had a substantively different interpretation of the meaning and implications of test score data than teachers, leading to conflict and debate. In fact, settings where individuals interact across department or roles are more likely to involve conflicting ideas about appropriate interpretations of data and about appropriate responses than settings where individuals interact within departments or roles (Coburn et al., 2009).

Taken together, this research suggests that while assessments, tests, observations, evaluations, and numerous other sorts of data provide information to people at various levels of the system, how these individuals use this information depends centrally on how they notice, interpret, and construct an understanding of the implications of data for action. Interpretive processes—*noticing, interpreting, and constructing implications*—are influenced by individual beliefs, knowledge, and (at least theoretically) motivation. But, they are also influenced by patterns of social interaction as well.

ORGANIZATIONAL AND POLITICAL CONTEXT OF DATA USE

A second key lesson from the research on data use is that the process of data use is shaped in significant ways by the organizational and political contexts in which it takes place. The organizational and political contexts for public schools are quite complex. Public schools are a multilevel system, with the expectation that data processes unfold at multiple levels simultaneously (Honig & Venkateswaran, *in press*). Data processes also exist in, and are intertwined with, a highly politicized environment, with multiple constituencies to serve and multiple goals. Here, we return to Figure 1, focusing attention on the outer circle. We ask, What are the organizational and political contexts that matter for data use? How do these contexts influence how the process of data use unfolds?

Existing research identifies numerous dimensions of the organizational and political context that matter for data use. Here, our goal is not to be comprehensive but rather to illuminate how some of these different dimensions interact to shape the process of data use. We also seek to move beyond a list of contextual conditions, to begin to specify the relationship between these contextual conditions on the one hand and the process of data use on the other.

We begin at the most proximal level, discussing how organizational routines guide who interacts with who around what data in what ways. We then show how the configuration of time, access to data, and organizational and occupational norms influence what data people even notice and the dynamics by which they interact in data use routines. We argue that school and district leadership plays a role by influencing each of these other dimensions of context. Finally, we illustrate how these organizational dynamics are intertwined with and influenced by relations of power and authority.⁴

⁴Although we do not discuss these here, other aspects of the organizational and political context that may influence data use include the following: formal positions and roles, such as data coaches or reading coaches (Lachat & Smith, 2005; Marsh et al., 2009); the hierarchical and differentiated organization of the school district central office and overall

Data Use Routines

Though often taken for granted, data use routines can play a significant but subtle role in how the process of data use unfolds. An *organizational routine* is a “repetitive, recognizable pattern of interdependent actions, involving multiple actors” (Feldman & Pentland, 2003, p. 95). We define “routines for data use” as the modal ways that people interact with data and each other in the course of their ongoing work. Data use routines may be informal such as when a superintendent regularly asks for reports from the director of assessment that she then peruses with members of her cabinet or when principals draw on spending data in their quarterly meetings with the school site council. Or they can be highly designed and structured, as is sometimes the case with grade-level meetings for teachers that are guided by protocols and facilitated by a school coach or the principal. Data use routines can be designed or naturally occurring and evolving. The defining criteria for a data use routine is that it is recurrent and patterned interaction that guides how people engage with each other and data in the course of their work.

Existing research suggests that data use routines are a key context for data use because they “fram[e] and focus interactions among school staff” (Spillane, in press, p. 4). They do so by bringing a particular configuration of people together around a particular set of data and structure their interactions in specific ways. First, how a routine is configured, whether by design or in its naturally occurring form, organizes who is in the room for data conversations. In some schools, teachers primarily look at data in their grade-level groups or departments. In others, data use routines bring teachers together as a whole school. At the central office, data use routines may involve the superintendent and her cabinet or may mainly happen within units in the district office. Some data use routines, such as those documented by Honig and her colleagues (2010) and by Supovitz (2006), bring together individuals from the central office with people from schools.

The configuration of people matters because, as we have discussed, different people come to the table with different beliefs and knowledge, which shapes how they interpret data and the level and kind of negotiations they have over the implications of the data for action (Coburn et al., 2009; Spillane, Parise, & Sherer, 2011). Thus, to the degree that routines influence patterns of interaction, they are likely to influence the interpretive process—*noticing data, interpreting it, and constructing implications for action*—as well.

Second, routines focus attention and thus what people notice and discuss. Routines are often centered on a specific kind of data. For example, many data use routines bring teachers or others together to examine standardized test scores (Marsh, in press). However, it is possible that data use routines can focus on other forms of data, such as student work (Gearhart & Osmundson, 2009; Gearhart et al., 2006; Little, Gearhart, Curry, & Kafka, 2003), records of practice (Horn & Little, 2010), or evidence from observations or experience (Honig et al., 2010; Ikemoto & Honig, 2010). Depending upon how a routine is configured, participants spend their time looking at some data and not others, about some subjects and not others, related to some aspects of student learning and not others (Spillane et al., 2011).

schooling system (Coburn et al., 2009; Thorn, Meyer, & Gamoran, 2007); rules and policies, such as specifications of how teachers use their non-instructional time in union contracts (Marsh et al., 2006); external organizations and actors (Burch & Hayes, 2009; Datnow & Honig, 2008); and trust (Herman & Gribbons, 2001; Ikemoto & Marsh, 2007; Ingram et al., 2004).

Routines also influence how teachers and others talk with one another in social interaction. They can alternatively open up or close down opportunities for learning, shaping opportunities to notice data and the nature of joint interpretation (Horn & Little, 2010). For example, Horn and Little (2010) document how a routine of “normalizing,” or defining a classroom problem as normal, closed off conversation, preventing teachers from delving deeper into the causes of the issue raised by evidence from the classroom. As this example suggests, while conversations in data use routines can spur action or change, groups may also come to interpret data and implications for action in ways that maintain the status quo. Ultimately, in bringing together people and focusing and framing their attention, routines for data use are a consequential context for how the process of data use unfolds.

Time, Access to Data, and Norms Influence Routines

Other dimensions of the organizational context, in turn, influence how data use routines unfold. Here, we argue that the configuration of time, access to data, and norms of interaction influence what data people even notice and the dynamics by which they interact in data use routines.

Time

Time is a central element in how interaction around data is organized. It takes time to collect and analyze data and collectively debate implications for decision making. For teachers, principals, and district leaders, time for data use is in short supply (Honig et al., 2010; Ikemoto & Marsh, 2007; Ingram et al., 2004; Little et al., 2003; Marsh et al., 2006; Means et al., 2007, 2009; Weinbaum, 2009). Theoretical work and some preliminary research at the district level suggest that the quality of decisions degrade as resources to support decision making decline. In the absence of time to debate conflicting interpretations of data and search for and evaluate different solutions, decision making gets increasingly drawn out, unresolved, and conservative (Coburn et al., 2009; Cohen, March, & Olsen, 1988).

Availability of Data

As discussed earlier, the configuration of data routines draws teachers’ attention to some data and not other data. But, this is predicated on systems and structures that bring data into conversations in the first place. Thus, the availability of data matters for how routines unfold. Organizations collect certain kinds of data and not others. This data is available to some people and not to others. Data is available on a range of different time scales—some immediately, some not until months later. As scholars point out, what data is available to whom and when is partially a function of the technological infrastructure for data collection, storage, and retrieval (Lachat & Smith, 2005; Marsh et al., 2006; Means et al., 2009; Means, Padilla, & Gallagher, 2010; Thorn, 2001; Wayman, 2007; Wayman, Conoly, Gasko, & Stringfield, 2008; Wayman, Stringfield & Yakimowski, 2004). But it is also a function of the human infrastructure: How individuals in different parts of the organization are connected to each other shapes the flow of information (Coburn, 2010; Daly & Finnigan, in press; Honig, 2006). For example, Honig (2006) shows that one of the main roles of district administrators who were working directly

with schools-community partnership sites was to bring information about these sites' needs and implementation efforts to the attention of district leaders in decision making roles.

Norms of Interaction

Occupational and organizational-specific norms further guide interaction within data use routines. At the most macro level, occupational norms of privacy in teaching work against teachers sharing their practice with their colleagues (Little, 1990; Lortie, 1975; Marsh et al., 2006). Even as more and more intentional routines are designed to bring teachers together to share their practice in discussions of data, norms of privacy leave the conversation at the level of the superficial, such that it is unusual for teachers to talk in depth about their practice and share evidence of student learning with their colleagues (Little, 2007; Little et al., 2003). Some schools do develop local norms of inquiry or collaboration. In these schools, teachers are more likely to use data to support joint problem solving (Ikemoto & Marsh, 2007; Little, 2007; Symonds, 2004; Young, 2008). Schools with norms that enable teachers to share data about their classroom practice openly, critique one another, or ask challenging questions are more likely to have conversations that delve more deeply into issues of instruction and student learning (Little et al. 2003; McDougall, Saunders, & Goldenberg, 2007; Timperley, 2009).

Leadership

School and district leaders play a role by influencing each of these aspects of context: designing routines in the first place, allocating time, creating access to data, fostering norms of interaction, and participating themselves in data use routines. School or district leaders may *select or design data use routines* (Honig et al., 2010; Spillane et al., 2011; Supovitz & Klein, 2003). The choices they make about how the routine is designed have consequences for who is involved, how and how often they interact, and around what data (Sherer & Spillane, 2011; Spillane et al., 2011). For example, in their report on data use in 5 schools engaged in comprehensive school reform, Supovitz and Klein (2003) found that school principals and other leaders created a number of "innovative activities" that guided teachers' engagement with data and each other. One principal developed a routine of meeting individually with 4th grade teachers to plan how to move students to the next level in the high-stakes tests. In preparation, the principal assembled the previous year's test results and used this data to determine the instructional efforts she believed each teacher should take. The principal and each teacher then used this data and the principal's analyses to plan lesson sequences for the year. In developing this routine, this principal made important choices about what data to use, how some of the data would be analyzed, who would participate in the discussions, and what role the teachers would play in this data use routine.

School and district leaders also *configure time*, enabling or constraining teachers' and others' ability to engage in data use routines regularly or for extended periods of time (Coburn & Russell, 2008; Halverson et al., 2007; Young, 2008). Leaders, especially at the district level, make decisions about who gets *access to what data*. They filter large masses of data, selecting what data gets sent to schools and sometimes presenting the data in particular formats. This serves to focus attention, guiding conversation and debate (Halverson et al., 2007; Marsh et al., 2006; Thorn, Meyer, & Gamoran, 2007). School and district leaders also play a key role in establishing *norms*

of interaction. They can create a climate of trust and risk taking in schools, which enables teachers and others to share more freely and take the risks necessary to change their practice (Bryk & Schneider, 2002; Copland, 2003; Ikemoto & Marsh, 2007; Wayman & Stringfield, 2006). However, they can also use data to create a climate of fear and turmoil (Hallett, 2010). Leaders also may foster norms that establish data use as part of “the way we do things” at a school or district, leading to the development of more frequent or widespread data routines (Lachat & Smith, 2005).

Finally, school and district leaders play a particularly important role when they *participate in data use routines themselves*. School leaders’ questions, guidance, and statements can focus discussions about data in important ways, shaping how others notice and interpret, as well as the substance of the debate (Copland, Knapp, & Swinnerton, 2009; Earl, 2009; Halverson et al., 2007; Lasky, Schaffer, & Hopkins, 2009; Spillane, in press; Symonds, 2004; Young, 2008). For example, Lasky and her colleagues (2009) found that in the context of data routines, school leaders’ prompts pointed teachers to procedural rather than substantive issues and, at times, diverted teachers’ attention from the data altogether. But, other studies document school leaders’ efforts to keep teachers focused on student learning through repeated questioning and facilitation in the context of data use routines (Earl, 2009; Symonds, 2004). For example, Symonds (2004) found that school leaders in schools that were successful at closing the achievement gap between White and Asian students on the one hand and African American and Latino on the other were more likely to focus teachers’ attention on the achievement gap than schools where the achievement gap remained stable or increased.

Relations of Power and Authority

Finally, relations of power and authority—between schools and communities, schools and districts, and teachers and administrators—play a role in how data use processes unfold. Power and the political pressure it feeds is a near omnipresent characteristic of the context of public schools. Public schools are in the public domain. Multiple interest groups inside and outside the district with different stakes and, at times, different values pressure district and school administrators to pay attention to certain data and to make particular decisions. In spite of the fact that data use is often positioned as the antidote to overly politicized decision making at the school and district level, there is evidence that it is deeply intertwined with data use processes.

As Henig (in press) reminds us, information is power. The public release of data is intended to and often does reshape power relations between schools and their communities (Henig, in press; McDonnell, 2004). Community actors can and often do use performance data to push for changes at the school and district level, creating greater power for their positions and for themselves. Data use can also reshape power relations within schools and districts. Indeed, one purpose of data use, especially as part of accountability policy, is to create better monitoring over classroom instruction. Thus, data use routines—between districts and schools and within schools—may be, in part, mechanisms of managerial control (Hallett, 2010; Henig, in press; Spillane, in press).

While data can influence power relations, power relations can also influence data use (Henig, in press). More specifically, power relations can influence what data one notices as the very decision to seek further data can emerge in the midst of controversial issues or from political motivations (Englert, Kean, & Scribner, 1977; Kennedy, 1982, 1984). For example, Kennedy

(1982) recounts how political controversy relating to personnel matters brought a long-standing program to the attention of district staff in 1 of the 16 districts in her study. In the course of addressing the personnel issue, staff noticed and attended to previously “dormant” data. Thus, political processes shifted notions of what was important to pay attention to, which in turn raised the profile of certain kinds of data and not others.

Finally, relations of authority matter as well. Authority is power that comes with a particular role or position in an organization and can be exercised by any person holding that position (Scott & Davis, 2007). Research on data use suggests that people with different levels of authority have differential influence in the negotiation about the meaning and implications of data. For example, in a study of instructional decision making among district administrators, Coburn and her colleagues found that when there were differences in how individuals interpreted the data and its implications for action, those with authority nearly always prevailed. This suggests that authority plays an important role in the interpretive process and, thus, in how data use unfolds in social interaction (Coburn, 2005; Coburn, Bae, & Turner, 2008; Spillane, in press).

Taken together, the existing research provides evidence that interpretive processes unfold in and are influenced by a multilevel organizational and political context. At the most proximal level are data use routines that guide who interacts with who around what data in what ways. Data use routines, in turn, are influenced by the configuration of time, access to data, norms of interaction, and school and district leadership. Finally, relations of power and authority are important as well, shaping the dynamics of interaction within which interpretation, deliberation, and debate unfolds.

INTERVENTIONS TO PROMOTE DATA USE

A third key lesson from research on data use is that the nature of the intervention matters for how it interacts with contexts and shapes interpretive processes. There are currently a significant number of interventions to promote data use in schools and districts across the country. These interventions vary substantially. They can be as modest as a single protocol to guide conversation or as elaborate as a system of regular, interim assessments, supported by new technology to promote access to data, professional development to support interpretation, and requirements for weekly or biweekly data conversations among teachers and other staff. Further, accountability policy plays an increasingly important role, adding rewards, sanctions, and a lot of public attention to data into the mix. What these diverse interventions share is the intent to alter teachers’, school leaders’, and/or district leaders’ use of data in their ongoing work.

Here, we turn to the upper left corner of Figure 1, asking, How do interventions promoting data use interact with the organizational and political contexts? How do they shape the process of data use? We draw on existing research to illustrate how features of data use interventions shape political and organizational contexts and the process of data use in intentional and unintentional ways. We argue that understanding these linkages is critical as it can provide a foundation for understanding the mechanisms by which interventions produce outcomes that matter, a topic to which we return in the final section.

We begin by outlining 3 different types of data use interventions that we attend to in this review. We then review how different features of interventions influence the context and process of data use.

Types of Interventions

We identify 3 categories of data use interventions that move from targeted to multifaceted. First, there exists a raft of *tools* intended to foster data use. Tools are “externalized representations of ideas used by practitioners in their practice (Norman, 1988), which serve as mediating devices that are used to shape action in certain ways” (Sherer & Spillane, 2011, p. 616). Rather than dictating what people should do, Smagorinsky and colleagues argue that tools create the “potential for different kinds of action that may be realized in different ways by different participants” (as cited in Honig, 2008, p. 638). Tools intended to foster data use include protocols for examining data, software systems that organize and create reports of data (e.g., Quality School Portfolio [Chen, Heritage, & Lee, 2005] or Grow Reports [Light et al., 2005]), new formative assessments, processes for collecting and analyzing observational data, (e.g., the LearningWalk from the Institute for Learning [Ikemoto & Honig, 2010] or the Snapshot in Duval County [Supovitz & Weathers, 2004]), among others. There are also targeted supports for data use, including the development of data coaches or facilitators (Marsh, McCombs, & Martorell, 2009).

Second, in recent years, school districts and external organizations have developed a range of *comprehensive initiatives* to foster data use in schools. These initiatives often incorporate multiple tools along with professional development and new technology. They include such diverse strategies as district initiatives that couple interim assessments linked to pacing guides and curriculum standards that teachers are required to administer and discuss in teacher teams (Christman et al., 2009; Clune & White, 2008; Goertz, Nabors Oláh, & Riggan, 2010); school-level inquiry projects that tend to focus on a broad range of data, use protocols to guide data discussions, and frequently involve trained facilitators and/or professional development (Copland, 2003; Gallimore, Ermeling, Saunders, & Goldenberg, 2009; McDougall et al., 2007; Porter and Snipes, 2006; Saunders, Goldenberg, & Gallimore, 2009); and district data use initiatives that engage individuals at multiple levels of the system in data routines, use technological tools and protocols, and involve professional development (Ikemoto & Honig, 2010; Kerr et al., 2006; Marsh et al., 2006; Supovitz, 2006) among others.

Third, data use has been heavily promoted by district, state, and federal *accountability policy*. In accountability policies, data is the main way to evaluate progress and is linked to incentives for teachers and others to change their practice (Stecher, Hamilton, & Gonzalez, 2003). This approach is based on the assumption that the sanctions and rewards linked to data will (a) focus greater attention on student performance, thus increasing data use and (b) leverage the findings from the data to motivate educators to make instructional change to improve that performance.

Of course, these 3 categories of interventions are not mutually exclusive. Comprehensive data initiatives are composed of combinations of tools. Accountability policy sometimes triggers the development or adoption of individual tools or comprehensive initiatives. In addition, interventions can either be locally developed, and thus emerge from inside a school or organization, or adopted or imposed from the outside.

However, whether an individual tool, a comprehensive initiative, or accountability policy, whether coming from outside or emerging from within, we must understand how the intervention interacts with the existing organizational and political contexts of a setting and how it influences underlying data use processes if we are to understand the consequences of data use interventions.

Empirical and theoretical work suggests that how interventions shape these processes depends upon the features of the intervention itself.

Features of Interventions

Most studies of data use interventions tend to be descriptive (Knapp, Swinnerton, Copland, & Monpas-Huber, 2006). That is, they focus on describing the nature of the activities or strategies involved, without attention to either outcomes or the process by which these outcomes are achieved (Coburn & Turner, in press; Jennings, in press; Marsh, in press). Here, we draw on research that investigates the relationship between data use interventions and the context and process of data use. We identify 6 features of data use interventions that interact with the political and organizational contexts and influence the process of data use: designed routines, technological tools, protocols to guide interaction, professional development, sanctions and rewards, and systems of meaning. This list is not meant to be comprehensive. Rather, we emphasize features for which there exists empirical literature that helps explain how the feature interacts with either the context or process of data use.

Designed Routines

One of the central ways that data use interventions attempt to shift data use processes and outcomes is by introducing designed data use routines into schools and districts (Sherer & Spillane, 2011). Not all data use interventions employ this feature, but the creation of professional learning communities or inquiry teams that encourage teachers and others to work together to discuss data in structured and patterned ways appears to be increasingly common (Little, in press). These designed routines shape existing contexts by interacting with and potentially altering preexisting or naturally occurring data use routines in schools and district. In so doing, they have the potential to (a) shape what teachers or others notice; (b) alter patterns of interaction in ways that influence how people interpret and construct implications for action; and (c) influence individual and shared beliefs.

First, designed routines can influence data use processes by focusing attention on some data and not other data, thus shaping what participants notice and attend to (Ikemoto & Honig, 2010; Sherer & Spillane, 2011; Spillane in press; Spillane et al., 2011). For example, Spillane and his colleagues (2011) compared routines for data use designed and instituted by school administrators in 3 different Chicago elementary schools. They show that the design of these routines led teachers to focus on different kinds of information in different schools. While the designed routine in 1 school focused on benchmark assessments linked to the state standardized tests, data routines in other schools involved a broader range of data, including classroom assessments, information from teacher surveys, and classroom observations. Thus, when teachers interacted in data use routines, their conversations were centered on different aspects of and different evidence of student learning.

Second, designed routines often bring people together in new and different combinations (Coburn & Russell, 2008; Honig et al., 2010; Supovitz, 2006). By altering patterns of interaction, these designed routines may also influence the dynamics by which teachers and others interpret

data and construct implications for action. For example, Supovitz (2006) documents how designed data use routines in Duval County, Florida brought together individuals from the central office with school principals in regular, patterned ways to discuss data on the implementation of districtwide reforms. This routine served to bring school leaders into district-level conversations about the strategic direction of the district.

We know that who is at the table for data use conversations is critical, because the range of beliefs and knowledge present as well as the configuration of authority relations shapes what interpretations are brought to the table, as well as the negotiation over implications for action (Coburn et al., 2008, 2009). Indeed, several studies find that when designed routines brought school administrators together with teachers in new ways, administrators played an increased role in what teachers noticed about the data, how they interpreted it, and how they constructed implications for action (McDougall et al., 2007; Spillane et al., 2011). Thus, to the degree that interventions shape patterns of interaction through designed routines, they are likely to influence the dynamics of interpretation as well.

Third, when accompanied by the provision of adequate time, designed routines may also shape individual and collective beliefs. McDougall and colleagues (2007) provide evidence that teachers who participated in inquiry teams that included release time during the day to discuss student work changed their expectations for students compared with teachers in the same intervention without adequate time. The researchers argue that in-depth, open discussion of student achievement in the designed routines, enabled by sufficient time, brought teacher expectations to the surface and prompted individual and collective reexamination.

Technological Tools

Many interventions involve new technological tools. Means and her colleagues (2009) report that almost all school districts surveyed in a nationally representative sample had student data information systems in place and more than 75 percent had systems for analysis and organization of benchmark assessments and data warehouses with current and historical data on students. Technological tools can shape access to data (Kerr et al., 2006; Means et al., 2009; Wayman & Stringfield, 2006), which, in turn, has the potential to influence what teachers and others notice and talk about in data use routines. What data and in what form depends, in part, on the design of the system's technological infrastructure (Supovitz, 2006; Thorn, 2001; Wayman et al., 2008) and the configuration of data reports (Brunner et al., 2005; Thorn et al., 2007). For example, in their study of the use of Grow Reports in New York City, Brunner and colleagues (2005) found that the data reports that sorted students into levels of proficiency (far below, far above, etc.) for each state standard facilitated teachers' and others' attention to those students who were on the cusp of proficiency, or "bubble kids" (see also Supovitz, 2006).

But existing research suggests that some technological tools fall short when they create access to data that teachers do not find useful or relevant to their instructional decisions (Goertz et al., 2010; Means et al., 2009; Wayman et al., 2008; Young & Kim, 2009), limiting the degree to which they influence teachers' data use processes (Goertz et al., 2010). In addition, technological tools may be more effective in shaping interpretive processes when they are accompanied by training on how to use the system, something that is often lacking (Means et al., 2009).

Protocols and Skilled Facilitation

Some interventions provide explicit protocols, at times accompanied by skilled facilitation, to structure interaction in data use routines. Protocols are “procedural steps and guidelines . . . to organize discussion and structure participation” (Little et al., 2003), and existing research suggests that they have the potential to (a) shape data use routines in ways that influence interpretive processes and (b) alter norms of interaction.

Even though individuals rarely follow protocols completely, protocols nevertheless focus conversation in important ways (Earl, 2009; Horn & Little, 2010; Ikemoto & Honig, 2010; Lasky et al., 2009; Little & Curry, 2009; Timperley, 2009). While some protocols prompt teachers and others to talk about specific evidence of student learning or specific instructional strategies, others prompt more general conversation or, even, a tendency to “turn away” from data (Earl, 2009; Lasky et al., 2009; Little et al., 2003; Timperley, 2009). This, in turn, can shape what teachers notice because the protocol and conversation that ensues can focus teachers’ and others’ attention on some data and not other data, and can sometimes divert attention from data completely (Ikemoto & Honig, 2010; Sherer & Spillane, 2011; Spillane in press; Spillane et al., 2011). Protocols in combination with skilled facilitation—especially by school administrators—may be more likely to focus conversation on the data itself and implications for practice (McDougall et al., 2007; Supovitz, 2006) than protocols alone.

Protocols may also influence norms of interaction. Well-structured protocols can create a safe space for conversation by guiding who talks, how much, and in what ways (Marsh, in press; Murnane, Sharkey, & Boudett, 2005; Nelson & Slavit, 2007), preventing any one person from dominating conversations and allowing differences of opinion to come to light. Yet, protocols alone may not be sufficient for changing long-standing occupational norms of privacy in teaching. Because norms of non-intervention and maintaining harmony often prevent teachers from engaging in challenging investigation of teaching and their own classroom practice, skilled facilitation may be important for productive social interactions around data use (Little et al., 2003; Nelson & Slavit, 2007).

Professional Development

Professional development on either the mechanics of data use or on subject matter content has the potential to shape interpretive processes indirectly by influencing the knowledge and beliefs teachers and others draw upon as they notice data, interpret it, and construct implications for action. When interventions provide professional development or coaching on the mechanics of data use, teachers’ knowledge about asking questions, selecting appropriate data, and drawing appropriate inferences increases (Armstrong & Anthes, 2001; Chen et al., 2005; Datnow, Park, & Wohlstetter, 2007; Fuchs, Fuchs, Karns, Hamlett, & Katz, 1999; Ikemoto & Marsh, 2007; Supovitz, 2006), although knowledge may increase in some respects but not in others (Gearhart & Osmundson, 2009) and not all professional development results in such growth (Weinbaum, 2009). Similarly, although some studies suggest that professional development can influence subject matter knowledge (Ikemoto & Honig, 2010), others report that it does not always offer sufficient support or help teachers to develop the knowledge necessary to connect interpretations

of data into implications for their own specific teaching practice (Gearhart & Osmundson, 2009; Massell & Goertz, 2002; Means et al., 2010).

Sanctions and Rewards

In this era of accountability, it is increasingly common for data use interventions to involve sanctions and rewards for performance, with data as the arbiter of performance (Jennings, in press). Linking data use with sanctions and rewards, especially the degree to which attributions of success and failure are publicized widely, may alter relations of power in ways that shape interpretation and action (Henig, in press; McDonnell, 2004). Indeed, there is evidence that accountability policy reshapes power relations between schools and communities, causing school leaders to feel greater pressure from the district and from local communities to improve test scores in order to maintain public support and funding (McDonnell, 2004). This, in turn, shapes their construction of implications for action: their sense of what they must do to promote data use and instructional change in their school (Fairman & Firestone, 2001).

Administrators at the school and district levels have responded to increased accountability pressure with increased monitoring. In so doing, they have designed data use routines that serve as a form of surveillance (Goertz et al., 2010; Hallett, 2010; Honig et al., 2010; McDougall et al., 2007; Spillane et al., 2011). For example, Hallett (2010) shows how one principal in Chicago developed a routine by which she inspected teachers' grades and evidence from student work as a mechanism to see what was going on in teachers' classrooms and ensure that teachers were teaching to the standards. At the district level, Goertz and her colleagues (2010) document a similar phenomenon. District leaders held meetings with principals to publicly share and discuss benchmark assessment data reports for each school in what was intended to be a supportive discussion but that principals came to experience as a form of evaluation. Thus, pressures associated with sanctions, rewards, and the public nature of data altered the function of data use routines in ways that shifted power relations between participants (Hallett, 2010).

Systems of Meaning

Finally, a handful of studies highlights a much more subtle way that interventions influence interpretive processes at the center of data use: By providing systems of meaning—including categories, classification systems, and logics of action—that become embodied in data use routines (Little, in press; Sauder & Espeland, 2009; Spillane, in press) and shape interpretive processes in important ways (Little, in press). We know the most about the role of systems of meaning in accountability policy, but it is conceivable that other kinds of interventions have a similar effect. For example, No Child Left Behind (NCLB) put forth a bevy of categories for understanding school and district performance, including the now-iconic categories of below basic, basic, proficient, and advanced as well as the categories for the key subgroups. These classification systems have become embedded in the way that data are collected and presented to teachers and others (e.g., in Grow Reports, discussed above). They also influence how protocols are structured to guide data use routines. Close-in studies of conversations in data use routines provide evidence that teachers and others invoke these categories as they interpret data and discuss implications for action (Little, in press; Spillane, in press). In reviewing the research on teachers' talk in data

use routines, Little (in press) argues that “classificatory talk” pervades teachers’ discussion of data. Teachers draw on key categories to “assign various meanings to data, make inferences from data, create explanations for observed patterns, or imagine appropriate responses to the patterns they detect” (p. 28; see also Blanc et al., 2010). Thus, categorization systems that are promoted by policies such as NCLB can influence, not only how teachers, school leaders, and district personnel look at, analyze, and make meaning of data, but also how they organize instructional responses (Coburn & Turner, in press).

Accountability policy also influences data use routines by providing “logics” of action, or organizing principles that specify both goals and the appropriate means for achieving the goals (Friedland & Alford, 1991). These logics can become bound up in the very design of data use interventions (Hallett, 2010; Spillane, in press). For example, Spillane (in press) argues that the data use routines he documented in his study of elementary schools in Chicago embodied logics promoted by the accountability movement. Spillane shows that in spite of the different ways that principals designed data use routines across the 3 schools in his study, all the routines were guided by an accountability logic involving curricular standardization, a primacy on student achievement tests as measures of progress, and a focus on making classroom practice more transparent. Thus, Spillane argues, the data use routines served to bring these new ideas about the social organization of schooling firmly into the school, reshaping teacher and administrator roles and the power relations between them.

Taken together, this analysis highlights a number of features of data use interventions that alter political and organizational context and the process of data use in schools and districts. Several features of data use interventions—designed routines, technological tools, protocols and skilled facilitation, sanctions and rewards, systems of meaning—can play an important role in how data use routines unfold in schools and districts, shaping administrator roles, patterns of interaction, and underlying interpretive processes in consequential ways. Other features can influence norms of interaction, including protocols and skilled facilitators. Still others—like professional development—influence the beliefs and knowledge that individuals and groups draw upon as they notice data, interpret it, and construct implications for action.

By highlighting the research that draws links between data use interventions and the contexts and process of data use, we provide a way of understanding how research on interventions can intersect with research on organizational and political contexts on the one hand and research on the underlying interpretive processes on the other. In so doing, we begin to lay the foundation for understanding the mechanism by which interventions produce data use outcomes of value. However, at the same time, it is clear that not all interventions interact with contexts and shape data use processes all the time or in the same way. Understanding when and under what conditions a given feature of data use interventions interacts with context and shapes the processes of data in what ways is an area that is ripe for future investigation.

OUTCOMES OF DATA USE

The degree to which interventions interact with political and organizational contexts to shape interpretive processes is important because it has consequences for diverse outcomes. Those promoting interventions for data use make various claims about the outcomes: increased student learning, improved test scores, educators’ changed attitudes about student success, improved

practice, greater efficiency, school improvement, organizational learning, and organizational transformation. Part of the challenge of sorting out these outcomes is that different scholars focus on outcomes at different levels of the system (classroom, school, and school district) and units of analysis (individuals, groups, and organizations as a whole). Furthermore, different scholars conceptualize outcomes at a given level in different ways, creating more complexity.

In this section, we return to Figure 1, focusing on the dimensions in the bottom right corner. We ask, What are the outcomes of data use? What are the pathways between intervention and outcomes? We put forth one way to think about and organize the potential outcomes of data use. We start by discussing organizational change, arguably the least familiar and certainly least studied outcome. We then move on to changes in practice and, finally, student learning. Throughout, we draw on existing literature to provide insight into possible pathways by which interventions interact with political and organizational context and shape data use processes to influence these various outcomes. And, we highlight the ways in which these outcomes, in turn, may be linked to one another.

Organizational Change

Scholars of organizations insist that organizations are more than the sum of the individuals that populate them (Scott & Davis, 2007). Thus, it is also possible to conceive of change in organizations that is more than the sum of change in individuals' practices. Although less common in studies of data use in public schools, some scholars have focused attention on these sorts of organizational outcomes, including changes in policy or strategic direction (Coburn et al., 2009b; Supovitz, 2006), changes in organizational structure (Thorn et al., 2007), and changes in the way work and work roles are organized (Honig, 2008; Honig et al., 2010; Sherer & Spillane, 2011; Spillane et al., 2011; Supovitz, 2006). It is possible to study organizational change at the school level (e.g. Sherer & Spillane, 2011) or the school district level (e.g. Honig, 2008; Honig et al., 2010; Supovitz, 2006) or to study the system of public schooling as a whole (e.g. Henig, in press). What is important here is that these are changes that go beyond individual practice and persist in the face of the turnover of individual personnel (Sherer & Spillane, 2011).

Organizational learning theorists remind us that change does not always equal improvement (Levitt & March, 1988). Organizations can learn in a way that reinforces existing practice, leading to stability rather than change (Argote, 1999; Glynn, Lant, & Milliken, 1994; Levitt & March, 1988; Feldman & Pentland, 2003). Changes in policy, structure, or the organization of work may also produce what some perceive to be negative outcomes.

To date, few studies have addressed the impact of data use interventions on organizational change. Yet those that do, provide a remarkably consistent, if general, portrait of the pathways between interventions and organizational change. These studies suggest that organizational change can result when groups or individuals engage in an iterative process of noticing, interpreting, and constructing implications for action in the context of data routines. When organized strategically, data use conversations, and the incremental decisions that result, can add up to substantial changes in policy, the organization of work, and work practices themselves (Honig, 2008; Honig et al., 2010; Sherer & Spillane, 2011; Supovitz, 2006; Supovitz & Weathers, 2004). For example, Honig and colleagues' study of 3 reforming school districts (2010) shows that central office leaders' ongoing data routines were central to their ability to transform the way

central office work was organized. These routines, and the degree to which they focused on data that showed what was actually happening rather than impressions, fostered norms of self-reflection and openness to data. Iterative data use routines also provided information that enabled continued adaptation of their efforts, leading to substantial organizational change over the long term.

Organizational change may be more likely when data use routines are designed to be interlocking and stretch across multiple aspects of the district, as was the case in Duval County, Florida (Supovitz, 2006). In this case, the overlapping, interlocking nature of the data use routines led to the development of shared understandings that subsequently guided interpretation, leading to more coordinated action systemwide. Furthermore, changes in the organization of work and work practices achieved through iterative conversation in data use routines can be sustained in the face of changes of individual personnel, even as the routines themselves evolve over time (Sherer & Spillane, 2011).

Change in Practice

The theory of action underlying many data use interventions is that teachers, school leaders, and district administrators will examine data and adjust their practices to support student learning. As such, teacher and administrator practice is a key interim outcome for data use interventions. “Practice” can be understood as “the coordinated activities of individuals and groups in doing their ‘real work’ as it is informed by particular organizational or group context” (Cook & Brown, 1999, pp. 386–387). For teachers, changing practice in response to data may mean altering instructional strategies, grouping, instructional materials, or other dimensions of the classroom. It may also mean changes in the ways that they interact with one another or shifts in the roles that they take on in schools and districts. For school leaders, changing practice may mean new roles and responsibilities. It may also mean shifting the way they interact with teachers, parents, and students. Finally, for district administrators, changing practice may mean altering the ways they go about the task of making decisions or setting new policies, but it may also mean changing the way that they work in relation to each other and those in schools.⁵

Like organizational change, it is important to remember that change in practice may not always be positive, as when teachers and administrators game the system (Booher-Jennings, 2005; Heilig & Darling-Hammond, 2008), take measures to narrow the curriculum (Diamond & Cooper, 2007; Hoffman, Assaf, & Paris, 2001; Marsh, Hamilton, & Gill, 2008; Ogawa, Sandholtz, & Scribner, 2004; Sloan, 2006; Wright & Choi, 2006), or make short-term, superficial changes in practice (Diamond & Cooper, 2007).

Existing research has begun to provide insight into the ways in which interventions shape the context and process of data use to influence teacher and administrator practice. In terms of *administrator practice*, we know that some interventions institute new data use routines that bring administrators together with others—teachers, coaches, and school and district leaders—in new ways (Honig et al., 2010; McDougall et al., 2007; Spillane et al., 2011; Supovitz, 2006).

⁵In this section, we are focused on change in practice that results from engagement with data. However, it is important to note that data use is itself a form of practice in the Cook and Brown (1999) sense. Please see Coburn and Turner (in press) for a fuller treatment of the practice of data use, both conceptually and methodologically.

Participation in these new routines can influence how and how often administrators give feedback to teachers and others (McDougall et al., 2007; Spillane et al., 2011), the content of that feedback (McDougall et al., 2007), and administrators' broader strategies for providing support and supervision (Honig et al., 2010; Ikemoto & Honig, 2010). For example, in their study of 15 Title I schools—9 involved in an initiative focused on developing inquiry teams and 6 control schools—McDougall and his colleagues (2007) found that principals in the treatment schools were more likely to participate in teacher inquiry meetings and professional development. When they participated, they were more likely to provide feedback that focused teachers' attention on data on student learning during data deliberations.

Changes in administrator practice can have important consequences for *teacher practice*. Recall that school and district administrators can play an important role in the interpretive processes at the center of data use when they participate with others in data use conversations. Because of the authority relations involved, principals' interpretation of data and construction of implications for action may be quite influential. Indeed, when administrators respond to test score data in the context of accountability policy with increased calls for test preparation, narrowing curriculum, or focusing on children at the margins of proficiency (bubble kids), we are more likely to see these practices on the part of teachers (Booher-Jennings, 2005; Bulkley, Fairman, Martinez, & Hicks, 2004; Christman et al., 2009). Furthermore, studies of comprehensive initiatives suggest that when administrators participate with teachers in data use routines, it can create stronger linkages between administrators' actions and teacher practice (McDougall et al., 2007; Spillane et al., 2011), although the impact on teachers' practice that results depends upon what school leaders emphasize and, perhaps, the nature of the data use routine itself. For example, Spillane and his colleagues report that data use routines that drew on an accountability logic emphasizing monitoring and surveillance led to increased standardization across classrooms and greater coupling between teachers' classroom practice and the environment (Spillane, in press; Spillane et al., 2011).

Student Learning

Student learning is perhaps the most oft-cited of outcomes in the data use literature. For educators and researchers alike, student learning is the bottom line. However, there is considerable debate among those in the measurement and assessment community about what constitutes valid measures of student learning and the relationship between achievement on tests and student learning (Baron & Wolf, 1996; Herman & Haertel, 2005; Ryan & Shepard, 2008). And, indeed, perhaps reflecting the multiple viewpoints in this debate, studies of data use rely upon a wide variety of measures, including classroom assessments, performance assessments, and, most frequently, large-scale standardized tests to measure student learning (Black & Wiliam, 1998; Young & Kim, 2010). With the advent of No Child Left Behind, scholars (and those in schools and districts) are beginning to be attend to relative achievement between students of different racial and ethnic groups as well as special education and language status. Thus, studies increasingly investigate the degree to which data use interventions influence the long-standing "achievement gap" between White and Asian students on the one hand and African American, Latino, and Pacific Islander students on the other (e.g., Snipes, Doolittle, & Herlihy, 2002; Symonds, 2004).

The pathways between interventions to promote data use and these student outcomes are less clear. While there is an accumulating body of research on the impact of data use interventions

on student outcomes, especially related to the introduction of new assessments (for reviews, see Black & Wiliam, 1998; Fuchs & Fuchs, 1986; Jennings, in press; Marsh, in press; National Research Council, 2011; Young & Kim, 2009), this research rarely includes an investigation of the process by which these outcomes are achieved (Coburn & Turner, in press; Marsh, in press; Jennings, in press). However, a handful of studies do link interventions to context, data use process, and outcomes, providing insight into at least a few possible pathways from intervention to student learning. These studies tend to emphasize *either* the ways that intervention shape deliberation and discussion through protocols, facilitation, and administrative involvement in ways that influence student learning *or* the degree to which they influence teachers' individual knowledge through professional development.

One set of studies focuses on the degree to which interventions influence student learning by shaping the nature of teachers' interaction in data use routines. In their study of a comprehensive initiative focused on the implementation of grade level inquiry teams, Saunders and his colleagues (Gallimore et al., 2009; McDougall et al., 2007; Saunders et al., 2009) provide evidence that schools with strong implementation of the intervention significantly outperformed control schools on the SAT-9 achievement test (conservative effect size of 0.8). Drawing on qualitative work, they argue that this result is related to differences in the ways that teachers interacted in data use routines. Because their study was longitudinal, they are able to show that the nature of this conversation—and student learning outcomes—changed when the model added professional development, skilled facilitation, and more active involvement of school leaders in data conversation. These features, along with release time for teachers, shifted the nature of conversation in data use routines in ways that shaped what teachers noticed and how they constructed implications for action. For example, a comparison of teacher talk in data use routines in experimental versus control schools shows that teachers in the treatment schools were more likely to attribute student achievement to specific instructional actions while teachers in control schools were more likely to attribute it to student traits or non-instructional explanations. These differences, in turn, were associated with increases in student learning as measured by standardized achievement tests.

A set of studies of the introduction and use of benchmark assessments in Philadelphia provides additional evidence that school leaders can be influential in data use routines. Christman and her colleagues (Blanc et al., 2010; Christman et al., 2009) found that using benchmark assessments and other features of managed instruction did not produce student learning gains unless it was accompanied by strong instructional leadership in the school, a statistically significant predictor of learning growth (effect sizes ranged from 0.11 to 0.17) (Christman et al., 2009). Drawing on their qualitative data, the researchers show that teachers and school leaders in most schools focused on short-term solutions in data use routines like test-taking strategies (Blanc et al., 2010; Christman et al., 2009). That is, teachers rarely addressed issues in their own instruction. However, school leaders with strong instructional leadership were able to focus teachers' attention on the implications of data for their classroom instruction. In one case-study school, the school principal structured grade-level discussions around analysis of data and instructional issues, encouraged teachers to connect benchmark data with instructional tools like the curriculum standards, and hired teacher leaders who worked with teachers to interpret and connect benchmark assessments with instructional strategies (Blanc et al., 2010). Administrators with strong instructional leadership also used data to inform their own thinking on priorities for teacher professional development, shaping what resources they provided teachers to support data use (Christman et al., 2009).

In contrast, rather than focusing on teacher interaction in data use routines, Fuchs and her colleagues (1999) focus on how interventions shape teacher knowledge through the provision of professional development. They draw on data from an experimental study of an intervention that involved the introduction of new performance assessments in mathematics and professional development to support their use. They found that teachers in the treatment group had increased knowledge of the merits of performance assessment and how to use them in their classroom (effect size=1.70) and change in self-reported mathematics practice (effect sizes ranging from .62 to 1.51, depending upon the dimension of practice measured). They also report that students in treatment classes showed growth in various aspects of mathematical problem solving, although there were stronger effects for students who teachers identified as above grade level (effect size ranging from .93 to 1.47, depending upon the dimension of problem solving measured) than for those at grade level (effect size ranging from .30 to 1.15) or those below grade level (effect size ranging from $-.28$ to .60).

Taken together, studies that attend to pathways from intervention to student learning, change in practice, or organizational change begin to provide guidance on possible mechanisms by which data use interventions produce the outcomes we care about. Studies attending to student learning identify 2 key pathways: (a) influencing the nature of teachers' conversations about data via new data routines, protocols, and active participation of school administrators and (b) influencing teachers' knowledge via the provision of professional development. Both of these approaches highlight the importance of teachers' underlying interpretive processes, showing how changing the dynamics of social interaction, on the one hand, or the knowledge teachers draw upon when they make attributions about assessments and draw implications for action, on the other, matter for the level of student learning in their classrooms.

However, the handful of studies that attend to the pathway between outcomes and student learning pay only limited attention to the political and organizational contexts of data use. Studies that attend to change in administrator and teacher practice broaden our understanding here, suggesting that interventions can shape access to data and norms of interaction in ways that influence deliberation in data use routines, with consequences for administrator and teacher practice. Further, interventions provide systems of meaning that foster new modes of interaction between administrators and teachers, shifting the relations of power between the two in ways that impact classroom practice.

Finally, research on organizational change reminds us of the importance of attending to data use processes over time. Iterative engagement with data in data use routines—especially to the degree that interpretations and implications for action are revisited, adjusted, adapted over time and across venues—may add up to changes in policy, the social organization of work roles, and levels of coordination across different parts of the system. These organizational changes may, in turn, influence individual teacher and administrator practice with implications for student learning, although this conjecture awaits empirical investigation.

DISCUSSION

Data use interventions are everywhere in public schools and districts. Tools to promote data use, comprehensive data use initiatives, and accountability policies with data use at their center seek to improve public school performance. In this article, we argue that in order to understand how

these data use interventions might influence teacher and administrator practice, affect student learning, and lead to organizational change we must understand how they interact with existing organizational and political contexts of schools and shape the underlying process of data use.

To that end, we have put forth a framework for understanding data use in the context of data use interventions. We draw on research and theory to identify key dimensions of the data use phenomenon and provide a way to understand how these dimensions might interact. More specifically, we argue that how individuals use assessments, test scores, or other data at the core of data use initiatives depends on how they notice, interpret, and construct an understanding of the implications of data for action. These interpretive processes are influenced by the complex and multilayered contexts of schools and districts, including data use routines, norms of interaction, relations of power and authority, among others. We then show how data use interventions interact with these contexts to shape the underlying interpretive processes in ways that have consequences—both good and bad—for student learning and other outcomes.

This framework contributes to research on data use by highlighting key pathways by which interventions shape, or fail to shape, data use outcomes. To date, few studies of data use that attend to outcomes also attend to the process by which these outcomes are produced (Coburn & Turner, in press; Jennings, in press; Marsh, in press). Similarly, few studies that attend to the underlying interpretive processes of data use or role of context attend to student learning (Henig, in press; Little, in press; Spillane, in press). The lack of connection between intervention, context, process, and outcomes is unfortunate. Absent information about the process of data use, we can know something leads to a given outcome but not know how or why. Absent information about context, we cannot explain why the same tools or initiatives foster positive outcomes in some settings and not others. At the same time, information about context and process in the absence of information about outcomes does little to help policy makers and school and district leaders make informed decisions about whether particular data use interventions are worth the investment of their efforts and scarce resources.

In this article, we review research that investigates the connections between context, interpretive processes, and outcomes to illustrate the ways that these pieces of the data use puzzle may implicate one another. Studies that explicitly investigate the relationship between interventions and student outcomes converge on 2 key levers by which data use influences student learning: (a) teachers' social interaction in data use routines and (b) individual teacher knowledge. Both of these dimensions are important because they influence teachers' interpretive processes: what they notice when they engage with data, how they interpret it, and how they construct implications for action. These interpretive processes, in turn, may influence how teachers respond to data in their classroom, which has consequences for student learning. Other studies help broaden our understanding of these pathways to student learning by identifying features of interventions and dimensions of context that shape teacher knowledge and the dynamics of social interaction.

To date, many of the potential pathways identified by the framework are suggested by existing research rather than investigated directly. For example, we know that teachers' conversations in data use routines shape their interpretive processes in ways that can influence their instructional practice with consequences for student learning. At the same time, we also know that relations of power and authority can influence teachers' conversations in data use routines and interpretive processes. But, there are no studies (that we know of) that investigate the link between relations of power and authority and student learning (see Henig, in press, for a review of the intersection of power and data use). There are similar issues with other dimensions of context (like norms of

interaction) as well as with key features of interventions (like sanctions and rewards). In laying out multiple dimensions that may matter in the pathway between intervention and outcomes and suggesting relationships between them, then, this framework provides quite a bit of fodder for future research. Here, we outline a few places to begin.

First, given the central role of interpretive processes in this account, it may be important to investigate the links between these processes and other aspects of the framework in greater depth. Research that develops a better understanding of the connections between processes and outcomes is an obvious place to start given that data use is generally advocated and undertaken with a desired outcome in mind. For example, existing studies that link intervention to student learning have investigated how interventions influence either teachers' individual characteristics (especially the role of professional development in building teacher knowledge) or social interaction (especially how designed routines and protocols and, to a lesser extent, school leaders, influence teacher talk in data routines). But, how does teacher knowledge influence the dynamics of interpretation and debate in social interaction? Similarly, we know that administrators can play an important role in shaping what teachers notice and in developing implications for action. And, a handful of studies suggest that when administrators are involved in data use routines, teachers are more likely to make changes in practice that increase student learning. But, how do these processes and outcomes vary depending upon the knowledge of administrators, instructional coaches, or facilitators with whom teachers interact in data use interventions?

More targeted investigations of the links between interventions and the process of data use may also be useful. Relevant questions might include these: When do interventions contribute to the well-established tendency for teachers and others to assimilate information into preexisting frameworks leading to stability rather than change and when do they prompt teachers to reconstruct their understanding of students, the subject matter, and instructional strategies in more fundamental ways? How do interventions shape data use routines in ways that harness the power of divergent points of view and differential expertise to spur learning rather than lead to the conflict and disagreement often documented in the literature (e.g. Coburn et al., 2008; Coburn et al., 2009; Hallett, 2003; Hallett, 2010; Spillane, in press; Spillane & Miele, 2007)? Similar questions can be asked to guide investigations at the intersection of context and processes of data use.

Second, this framework generates new directions for comparative research on data use interventions. We have identified 6 key features of interventions that seem to matter for the ways that data use interventions interact with contexts and shape data use processes. Yet the research on most of these features is mixed. Thus, we know that protocols can influence what teachers and others notice in data use conversations and how they draw implications for action. But, what are the qualities of protocols that focus teachers' attention on issues of student learning, and what are the qualities that focus it away from student learning toward general instructional strategies? Does it differ according to the organizational and political contexts that are present in a school? How do protocols interact with other features of interventions, such as professional development, systems of meaning, or the presence of sanctions and rewards? One can imagine similar research questions for each feature of data use interventions we identified. Knowledge generated from studies of this sort, not only have the potential to contribute to the field's understanding of data use, they have the potential to provide insight for redesigning existing interventions and improving data use efforts overall.

Finally, the framework broadens our understanding of the range of outcomes that may be important to attend to when studying the phenomenon of data use. For many scholars and

practitioners alike, student learning is the bottom line. And, indeed, there has been a great deal of attention to the relationship between data use interventions—especially those centered around formative assessment—and student learning outcomes variously defined (see Black & Wiliam, 1998; Fuchs & Fuchs, 1986; and Young & Kim, 2009, for reviews of this literature).⁶ Those studies that move beyond the relationship between data use and student learning tend to focus on teacher practice as a key interim outcome (see, for example, Christman et al., 2009; Gallimore et al., 2009; Fuchs et al., 1999; McDougall et al., 2007).

Yet, our analysis suggests that administrator practice may also be an important interim outcome to attend to. We show that administrators play a key role in shaping teacher practice by participating with teachers in data use routines, focusing teachers' attention on some data and not other data within those routines, and playing an active and influential role in constructing implications for action. Several studies show that these actions have implications for student outcomes. At the same time, there is evidence that administrators also shape contextual conditions—including time allocation, access to data, and norms of interaction—in ways that may influence teacher practice in potentially positive and negative ways. This suggests that there may be analytic benefits of attending to administrator practice as a key interim outcome for understanding teacher practice and student learning.

In addition, studies of data use only rarely attend to organizational change. Yet, while little studied, organizational changes may be quite consequential. Change in policy and strategic direction or the ways that work and work roles are organized have the potential to alter individual administrator and teacher practice on a widespread basis, as illustrated by Supovitz's study of Duval County, Florida, and Honig and colleagues' (2010) study of 3 major urban districts. Furthermore, precisely because these organizational changes are not located in specific individuals, but rather stretched across people, processes, and structures, they have a greater potential to be sustained than changes that focus on individual practice, given the high levels of turnover endemic in U.S. public schools (see Sherer & Spillane, 2011, on this point). Thus, attention to outcomes related to organizational change is a potentially fruitful approach for understanding the consequences of data use on a larger scale and extending beyond the reach of a single intervention.

It is worth noting that studying linkages that span across areas of the framework may require researchers or research teams to stretch across traditional disciplinary boundaries or research communities. This framework suggests that understanding the data use phenomenon requires bringing insights from the assessment and measurement community together with insights from social psychologists who study the dynamics of deliberation and debate in groups. It requires bringing insights from cognitive psychologists who study the microprocesses of noticing and attribution together with insights from organizational theorists who study how these processes unfold in the context of complex organizations and environments. And it requires bringing the lessons from political science into the fold, so that we can better understand how relations of power both inside and outside organizations play a role in people's experience of data use interventions, the dynamics of interpretation, and the nature of instructional change.

⁶Although, certainly, there could be more attention to the connection between comprehensive initiatives and student outcomes. A recent review of research on comprehensive data initiatives suggests that few studies attend to student outcomes and many that do have methodological problems that raise questions about their ability to draw conclusions about outcomes (Marsh, in press).

In many ways, the practice of data use is out ahead of research. Policy and interventions to promote data use far outstrip research studying the process, context, and consequences of these efforts. But the fact that there is so much energy promoting data use and so many districts and schools that are embarking on data use initiatives means that conditions are ripe for systematic, empirical study. These settings provide opportunities for research to learn from practice about the conditions that promote data use in schools. The framework we present here is intended to help provide guidance for this research. By emphasizing the nature of linkages between different facets of the data use phenomenon, this framework can inform the design of studies that are better able to connect different aspects of what has heretofore been a disconnected field. In so doing, we hope to spur a new generation of research on data use that draws on insights from different research communities to develop new knowledge that has the potential to inform the practice of data use and improve efforts to intervene.

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