Leadership and the Design of Data-Driven Professional Networks in Schools

Yi-Hwa Liou[1], Jeffrey Grigg[2], Richard Halverson[2]

1) University of California, San Diego. USA
2) University of Wisconsin, Madison. USA

PLEASE SCROLL DOWN FOR ARTICLE

Leadership and the Design of Data-Driven Professional Networks in Schools

Yi-Hwa Liou
University of California, San Diego

Jeffrey Grigg
University of Wisconsin, Madison

Richard Halverson
University of Wisconsin, Madison

Abstract

Using data from a multi-method comparative case study of two matched schools, this paper adds to the growing body of applications of social network analysis to the study of distributed leadership and accountability. We contrast two approaches to instructional leadership, prescriptive and discretionary, to investigate how leaders design professional networks to increase the availability and access of individuals with the expertise needed to perform the analysis required to conduct data-driven instructional improvement. We found that the prescriptive approach to instructional leadership uses comprehensive school reform as a focal artifact to facilitate the widespread use of data for learning when compared to a leadership perspective that aimed at cultivating teacher discretion. We conclude with a discussion of how the concept of cognitive load helps illustrate the design principles leaders can use to create data-driven professional networks in schools.

Hipatia Press
www.hipatiapress.com

El Liderazgo y el Diseño en las Escuelas, de Redes de Profesionales Basadas en Datos

Yi-Hwa Liou
University of California, San Diego

Jeffrey Grigg
University of Wisconsin, Madison

Richard Halverson
University of Wisconsin, Madison

Resumen

Utilizando los datos de un estudio de caso multi-metódico y comparativo de dos escuelas similares, este trabajo se suma a la creciente cantidad de programas de análisis de redes sociales para el estudio del liderazgo distribuido y la responsabilidad hacia los resultados. Comparamos dos enfoques de liderazgo instructivo, prescriptivo y discrecional, para investigar cómo diseñan los líderes redes de profesionales capaces de aumentar la disponibilidad y el acceso de las personas con la experiencia necesaria para llevar a cabo la mejora de la instrucción a través de un buen análisis de los datos. Descubrimos que el enfoque prescriptivo utiliza la reforma escolar integral como mecanismo central que ayuda a usar los datos, a diferencia de una perspectiva de liderazgo centrada en estimular las decisiones del profesorado. Se concluye con una discusión de cómo el concepto de carga cognitiva ayuda a ilustrar los principios del plan que pueden utilizar los líderes para crear, basándose en datos, redes de profesionales en las escuelas.

Palabras clave: responsabilidad escolar hacia los resultados, liderazgo instructivo, organización escolar, capital social, análisis de redes sociales.

Hipatia Press
www.hipatiapress.com

This paper presents a comparative case study about how leaders and teachers in two urban K-8 schools in the United States (U.S.) designed school capacity for using data to improve student learning. The schools were in the same district and alike in almost every external respect, with similar staff composition, student demographics, teacher and leadership experience. However, they differed in one crucial respect – one adopted a more prescriptive, school-wide direct instruction approach to teaching and learning, and the other cultivated the ability of teachers to use discretion to select appropriate instructional materials and classroom strategies.

Our paper examines how these instructional choices resulted in marked differences in how school leaders structured interactions around data use and staff confidence in using data. In the first section we explain how school accountability calls for a new form of data expertise in schools, and how leaders create professional networks to distribute and access that expertise. We present a comparative case study and the surprising finding which led to this investigation: the contrast between the two schools with respect to their confidence in using data. We describe the leadership priorities in the two schools, how the school principals deliberately shaped the work environments in two contrasting fashions which we refer to as *prescriptive* and *discretionary,* how the social network data conform to these different approaches, and how the prescriptive design offered teachers clear and regular access to the few individuals in their schools with the valued expertise. The paper concludes with a discussion of how the design of the prescriptive model resulted in several key design principles for creating a data-driven professional community.

Accountability, Distributed Leadership and Design

School accountability movements across the world have placed a premium on the abilities of school leaders and teachers to engage in "data-driven decision making" as a tool for school improvement[1]. Data-driven accountability calls on schools to translate information on the results of student learning into actionable plans to improve the instructional process (Elmore, 2000, 2005; Goertz, Olah, & Riggan, 2009; Halverson, 2010a, 2010b). While successful teachers have long used formative feedback to

improve student learning (Black & Wiliam, 1998), school accountability policies press school leaders to design data-driven instructional systems that provide classroom-level feedback for teachers to customize teaching to meet the needs of students (Halverson, 2010a, 2010b; Halverson, Grigg, Prichett, & Thomas, 2007).

The growing prevalence of data-driven instruction requires teachers to teach in new and different ways, and—in particular—demands that teachers consider new forms of student achievement information as they make instructional decisions (Jennings, 2012; Little, 2012; Turner & Coburn, 2012). In the early stages of design and implementation of these systems, teachers struggled to integrate summative student achievement data into their daily practice. The struggle was, in part, due to the mismatch between the training provided to teachers on using data to improve instruction and perceived preparedness in effectively improving their instruction using the trained knowledge and skills (Stanulis, Burrill, & Ames, 2007; Supovitz & Klein, 2003;Young, 2006). However, many educators quickly realized that, aside from the training issue, the summative data provided to schools were delivered too late to make a difference or did not match the curricula that teachers taught in their classes (Hamilton, Halverson, Jackson, Mandinach, Supovitz, & Wayman, 2009). In response, many teachers and leaders responded to the press to integrate achievement data by designing socio-technical systems that created and circulated the kinds of information that could support improved instruction (Halverson et al., 2007). Leaders worked with teachers to collaboratively build and implement new instructional initiatives, to collect data on their efforts and to reflect on and integrate these data into refined practices of teaching and learning.

The framework of distributed leadership (Spillane, 2006) is well-suited to trace how leaders, teachers and staff create policies and routines that shape school-wide practices. Studies on distributed leadership provide a useful framework in understanding complex leadership practices in school systems (e.g., Spillane, Kim, & Frank, 2012; Sun, Frank, Penuel, & Kim, 2013). Distributed leadership describes how leaders create systems of practice (Halverson, 2003) that shape or reform instructional practices in schools. This work involves creating new structures for interaction, and also developing the professional community among educators that allow for ongoing learning and development (Halverson, 2005; Little, 2003; Wenger, 1998). One way to understand the response of schools to meet the needs of

accountability policies is to study how school leaders created professional networks among educators to engage in data-driven instructional design practices.

A Network Perspective of Social Capital

Social network theory offers a model for analyzing professional interaction in schools. Researchers have used social network theory to investigate how the structure of a teacher's social network is shaped by the way in which school leaders distribute practices across network members, tools, and processes (Coburn & Russell, 2008; Gronn, 2002; Spillane, Halverson, & Diamond, 2004). Social network data—especially when used in concert with interview and observational data—are particularly well suited to address both the structure and embedded resources of the professional network (Daly, 2010; Penuel, Riel, Krause, & Frank, 2009; Penuel, Sun, Frank, & Gallagher, 2012). Bringing social network analysis tools together with distributed leadership allows us to explore the relations between leadership practices, professional community and teacher instructional practices.

   Social network methods are grounded in social capital theory. The concept of social capital has been widely studied and defined in the social science literature (Coleman, 1988; Nahapiet & Ghoshal, 1998). The central insight of social capital theory is the process of building trust as a way of understanding the formation of quality of social ties as well as the interplay between trust and quantity of these social ties (Burt, 1992, 1997; Coleman, 1988; Granovetter, 1982; Lin, 2001; Marsden & Campbell, 1984; Putnam, 1993, 1995). Coleman's (1988) analysis begins with the simple interaction of asking for and receiving advice or help. Social capital develops from this basic transaction. When community members ask for help, the network becomes centralized around those who provide help; when community members begin to ask one another for advice, the network becomes more distributed. Network interactions can be one-way (help seeker → help giver), reciprocal (help giver/seeker ↔ help seeker/giver) or multidimensional, in which many actors are both advice givers and seekers. Trust between actors in social networks may or may not coincide with organizational structures as the strength of social ties between actors varies dependent upon the level of trust between and among network members

(Granovetter, 1982; Marsden & Campbell, 1984). For example, as we demonstrate below, the trust that accrues around the ability of an administrator to address student disciplinary issues does not necessarily transfer to trust about instructional or community relations. Social networks formed by different purposes of social ties (network intentionality) are distinguished based on the kinds of expertise sought by actors (Wasserman & Faust, 1994). Because trust among actors differentiates around kinds of social interactions, it is difficult to consider a broad measure of organizational trust without considering the specific nature of the advice networks.

We consider how social capital theory can be used to analyze the interactions between and among network members as a way in which social capital is accumulated as assets in a social network (Lin, 1999). The network perspective of social capital provides insight into the social processes that are stretched across individuals within levels of educational system (Daly, 2010, 2012). It is particularly concerned with the patterns of social ties in which relational resources, such as knowledge and skills that travel across networks are embedded ties of social interactions as well as network position of individuals (Lin, 2009; Scott, 2000). Social network studies inside and outside of education suggest that informal social positions of individuals in networks may support and constrain the flow of relational resources (e.g., reform advice, knowledge and information, etc.), and how individuals gain access to and are influenced by these resources (Degenne & Forsé, 1999).

Social network research considers how individuals interact in the structures of the network. The pattern of ties and social network position are two core components of the structural aspect of social capital (Daly, Liou, Tran, & Cornilessen, 2013; Lin, 2009; Liou & Daly, in press; Wasserman & Faust, 1994).

- The *pattern of ties* forms an overall structure in which individual members are positioned differently based on the pattern of incoming and outgoing ties to others across the network (Wasserman & Faust, 1994). A densely connected network structure may facilitate more effective access to resources, such as knowledge, skills and materials, and may enjoy better access to information (Burt, 1992). Actors in dense networks may have greater advantages to effectively distribute

knowledge and information through which assets of social capital may develop (Coleman, 1988; Inkpen & Tsang, 2005; Smylie & Hart, 1999).

- Individuals who occupy a more central and influential *network position* are considered "hubs" and/or "connectors" and may have greater advantages to both seek and receive resources that are useful to achieve purposive goals (Ibarra & Andrews, 1993; Lin, 2009; Penuel et al., 2009). Such individuals are described to have high-degree centralities when compared to peripheral actors with lower degree centralities who have limited access to these resources due to relatively sparse ties to and from others (Scott, 2000; Tsai, 2001; Tsai & Ghoshal, 1998).

Given that dense networks and central actors are influential in moving resources across a network, exploring network structure and informal social network positions provides more insight into the extent to which resources (e.g., advice) are distributed and shared in professional communities in facilitating improvement efforts among teachers and other key network members.

Multi-Method Comparative Case Study

Our study investigates how leadership practices influence the degree to which the knowledge and practices of data-driven instruction are made available to educators. Our data is drawn from the Data-Driven Instructional System (DDIS) Project, a five-year National Science Foundation sponsored study of how school leaders create social and technical systems to help teachers use achievement data in their instruction. Using an explanatory case study design (Yin, 2009), the DDIS researchers used interview, observation, survey, and social network data as evidence to examine practices in nine schools in a Midwestern state. DDIS researchers purposively sampled elementary schools with documented improvement in student outcomes and that were led by principals with strong reputations for helping teachers understand and apply data to their teaching practices. In this study we report findings from two schools in a single urban school district, which we refer to here as Liberty School and Community School[2].

The DDIS study involved multiple channels of data collection. All relevant professional development and faculty meetings and events were observed over the course of a year, and researchers interviewed leaders,

teachers, staff, and volunteers (22 interviews at Liberty; 17 at Community). Interviews were recorded and transcribed, and both transcriptions and field notes were compiled and analyzed using the qualitative data analysis software NVivo 8. At the completion of fieldwork, all educators in the school were invited to complete a survey on their teaching practices, attitudes about school climate and leadership, and social network engagement[3]. The DDIS survey response rate was 92% at Community and 62% at Liberty. The social network aspect of the survey invited staff to nominate individuals to whom they went to for advice and support along six different dimensions: teaching reading, writing, mathematics, and science; addressing the needs of students who struggle academically; and addressing student behavior issues. The survey provided a roster of school staff to prompt recall of salient individuals (Wasserman & Faust 1994)[4]. This bounded network approach provides a more complete picture of organizational interactions (Lin, 1999; Scott, 2000). The social network data were analyzed with UCINET 6 (Borgatti, Everett, & Freeman, 2002) and represented using NetDraw (Borgatti, 2002). The following discussion draws data from across these channels to develop contrasting profiles of data use in two schools with significantly different approaches to instruction and student learning.

Liberty School and Community School

Liberty School and Community School share a long list of similarities (Table 1). Both schools are K-8 charter schools in the same urban school district, and consequently share similar external resources, including funding allocations, district staff support, and assessment and data collection protocols. Both schools are similar in size (between 600 and 650 students). Although the schools differ in their racial or ethnic profiles, both schools have considerable non-white populations and have nearly identical levels of poverty (approximately 70% eligible for free/reduced lunch) and academic proficiency (75-80% proficient in reading, 50-65% proficient in mathematics).

Table 1
Characteristics of Schools

	Liberty School	Community School
Grades	K-8	K-8
Location	Urban	Urban
Number of students	650	600
Eligible staff members	52	49
Ethnicity (%)		
Asian	5	30
African American	70	10
Hispanic	5	20
White	20	40
Special education students (%)	10	10
Students eligible for free and reduced lunch (%)	70	70
Proficient and advanced in Reading (%)		
4th grade	75	80
8th grade	75	80
Proficient and advanced in Mathematics (%)		
4th grade	60	65
8th grade	50	50

Note.—Data are reported from the 2006-2007 year and are rounded to the nearest 5% to preserve anonymity (and therefore may not add up to 100%).

The schools also share similar histories as well as teacher and administrator profiles. Both schools had previously been identified as underperforming by the state and were designated as turnaround schools. As shown in Table 2, the majority of staff in both schools had been employed there for at least five years; and over half the members of each staff held advanced degrees. Both principals had been working at their schools for at least five years and enjoyed the respect of district leaders and their own faculties. Because the schools were in the same district, they also shared similar instructional remediation and special education systems. Both convened "problem-solving teams" (Thomas, 2008) to systematically assess and address the needs of students who struggled with the instructional program. Both schools provided instructional support to teachers with literacy coaches.

Table 2
Demographics and Perceptions of Teachers and Administrators/Support

	Liberty School		Community School	
	Teacher	Administra-tor and support	Teacher	Administrator and support
Demographics (%)				
Female	73	6	82	77
Non-White	32	20	15	0
Masters+	50	90	68	76
Years teaching (>5 years)	73	80	71	82
Years in the current school (>5 years)	37	80	50	65
School leadership[a] (%)				
Regular feedback	78	90	92	94
Test score priority	95	95	89	94
Shared commitment	86	95	96	98
Evaluating progress	95	98	96	88
Use of achievement data[a] (%)				
Reviews useful data	64	90	93	93
State assessments[b]	77[*]	90[*]	61[*]	82[*]
Use of own data from PD/colleagues	76	80	64	60

Note.—$N_{Liberty}$ = 32 (62% response rate), $N_{Community}$ = 45 (92% response rate).   The percentage represents those who reported 'Agree' and 'Strongly Agree' from both teachers and administrators and support staff in each school.
[a]1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree; See Appendix for complete questions and factor loadings.
[b]Significant differences are found between teachers and administrators/support staff at both schools. [*]$p < .05$.

The DDIS survey revealed similar teacher and staff perceptions of school leadership and of the use of achievement data at the two schools[5]. Teachers from both schools reported similar levels of perceptions about leadership and the use of achievement data on the survey. Both Liberty and Community teachers reported similarly high focus on school leadership priorities. They

perceived an effective and ongoing evaluation system for teaching and learning, and they reported sharing a school-wide priority of improving test score results and student learning.   The overall perceptions of school leadership from both teachers and administrators and support staff at both schools are similar across the DDIS survey. Educators at each school report similar data-use practices as well. More than 60% of the educators at both Liberty School and Community School reported using annual state assessment data to modify their instruction (77% and 61% respectively), approximately two thirds reported collecting their own data to modify their instruction (76% and 64%, respectively), and over 80% of teachers reported turning to colleagues for help using achievement data to improve their instruction (95% and 84%, respectively). Finally, approximately 90% of teachers in both schools reported that the school reviews the kind of data they need to improve their instruction (95% and 96%, respectively). From the descriptive and survey data, it was difficult to tell these urban schools apart.

Data-Driven Anxiety

When we explored the interview data, however, we began to discern a difference in levels of anxiety and confidence among teachers at the two schools.   Teachers at both schools reported they were using state assessments and their own data to improve instruction, but they felt differently about how comfortable they felt discussing data (Liberty: $M = 3.97$, $SD = 0.80$ and Community: $M = 4.39$, $SD = 0.57$, $t = -2.22$, $p < .05$)[6]. We explored our qualitative data to investigate this difference in the extent to which teachers felt prepared to engage in data-driven instructional practices.

The teachers at Liberty School appeared anxious when discussing data-driven instruction. They were confident about how they were using data in their own classrooms, but uncertain about how their local practices related to the overall school goals and the standardized testing data. For example, one lower grade teacher at Liberty noted:

> [I]ndividual teachers have their own data, but as far as analyzing the big pieces of data that's all [the principal] coming with the Terra Nova tests and being like, 'This is this percent, and this is

> this percent.' And [the principal] does a good job of breaking it
> down so that we can all understand it because I stare at those grids
> and I don't get it, you know. To be honest it's a little
> *overwhelming* [emphasis added]. So she breaks it down so that we
> can all understand it … As far as like more informal assessments
> and things like that, it's all based on the teacher. (Liberty lower
> grade teacher)

This teacher distinguished the periodic review of standardized tests such as the Terra Nova, or "big pieces of data," and the formative data, referred to here as "informal assessments and things like that" which guide individual instructional choices. The principal took responsibility for guiding the staff through reflecting on standardized data, for which this teacher is grateful since she finds that these data to be "a little overwhelming."

The word "overwhelming" reappeared in the discussions about data at Liberty school. An upper grade teacher, for example said, "It [using data to improve student learning] is overwhelming and I think it can be a hindrance when you try to make change as a whole school." A different upper grade teacher followed suit:

> I do want to mention that it's [the support from lit coach, special
> education teachers, and counselor] somewhat effective because we
> feel included in understanding the data, but again sometimes we
> feel *overwhelmed* [emphasis added] because we have so much to
> do and data isn't as important as what we're doing in the
> classroom. (Liberty upper grade teacher)

Having the principal guide the annual data review is regarded as a valuable, but rare, instance of data-driven leadership at Liberty School. For the most part teachers are told to address their ongoing data needs (described by first teacher the "informal assessments and things like that") on their own. A different lower grade teacher described how she felt the responsibilities of using data to support student learning:

> Unfortunately … that's pretty much put on the teacher … a lot of
> it is for teacher. So it's our own time going and seeking people out
> … The speech teacher comes and works really closely with us and
> she'll come in and conduct a lesson within our regular setting just
> because having half special education, she services a lot of our
> kids … but then as far as we're going into teacher resources,
> things like that, you know, that's all pretty much that way.
> (Liberty lower grade teacher)

Another teacher expressed the press of developing the capacity to use data on her own as a mandate from school leaders: "A lot of it's like the teachers are saying this is too much work. How are we going to get this done and they are saying 'but it needs to get done.'" Teachers at Liberty School regularly stated that they were expected to use data to guide their instruction, but with the exception of the annual review by the principal, they were felt they were left on their own to do it. The leadership team clearly expected teachers to use data for instructional improvement, but the means to achieve that expectation was less clear to teachers.

At Community School, on the other hand, teachers expressed more confidence dealing with data, and we heard less anxiety than from Liberty teachers. A lower grade teacher at Community talked about her practices of using data:

> Certainly I use that data all the time. I know they have it ongoing because teachers are supposed to be using it as well. That's a piece I know we're working on … some people just … need additional training in how do you get things that way and how do you use that data and what does it show you … And I think we're still sort of moving on that path-people are more than willing to collect the data typically, but they get that it's important so they'll collect it, but they'll sometimes graph it. (Community lower grade teacher)

This teacher admitted that the process of using data to inform instruction is emerging, but her disposition toward the challenge is quite different. Another teacher described her positive feeling about how the progress of using data has been improved with training they received:

> I think, the goal was always to have some data but with the additional training and the additional people on the staff to do the training, there was more of an acceptance that you needed some data to evaluate. Not just getting back together after a month and saying 'How'd it go? Are we better or not?' We used to be a lot more informal about that but certainly we've become more efficient about using that sort of data with problem solving and the teams have gotten much better-the results have gotten much better since we started doing that. (Community lower grade teacher)

Community's principal summed up her sense that they are addressing the challenge by saying, "We've been trained."

What accounts for the feelings of being overwhelmed by data at Liberty School, and the shared sense of responsibility toward data use at

Community? How can we explain this difference in anxiety given the similarities between the schools? We believe this difference in sentiment is attributable to the divergent instructional philosophies and strategies adopted by the schools' leaders, which the social relations in the school reveal.

Discretionary and Prescriptive Leadership

The leaders at Liberty and Community had quite different approaches to improving teaching and learning across their schools. The principal at Liberty School focused on cultivating collaborative teams and enhancing teacher autonomy. This approach, which we characterize as *discretionary*, empowered teachers by granting them the freedom to make curricular choices among grade-level teams and relied on teacher effort and professionalism. The leaders at Community school also focused on creating collaboration, but through the adoption and implementation of Direct Instruction (DI), a comprehensive school improvement model that specifies a paced teaching plan with clear assessment standards. Rather than rely on teacher discretion to develop the instructional program, the leaders at Community exercised a *prescriptive* approach to leadership that dictated how teachers were to interact with students at all times. The following sections of the paper detail how these approaches to leadership shaped the professional communities of their schools.

The leaders at Liberty school adopted policies designed to improve student learning through cultivating teacher professionalism. We call this approach to instructional leadership *discretionary* because of the focus on enhancing teacher discretion played in the school instructional program. The principal of Liberty expressed her beliefs in building teacher autonomy in the following fashion:

> We are such a collaborative structure … because I really do believe in my teachers as professionals. It's very messy trying to … arrive at systems … [it] can be a long process. The system we're arriving at right now [is] for monitoring individual skills. And yet, I really do believe that what I am trying to build is consensus and commitment and not compliance … even though I stick some compliance mechanisms in there … But it definitely is a process of convergent thinking and convergent commitment as

> opposed to, you know, 'Here is this great tool we have because it
> is built into our curriculum.' (Liberty principal)

This quote is noteworthy because the principal is trying to build a consensus around a system guided by the teacher's ability to monitor student learning. At Liberty, leaders seek to establish an ethic of professional respect through consensus approach, which the principal admits is "messy" and "long" process. She resisted prescribing a single curricular program for the school, instead guiding the teachers to build curriculum maps that would document the practices they felt best met the needs of their students. Out of the curriculum maps, Liberty leaders hoped, would emerge an instructional consensus around which a data-driven culture could be built.

The Liberty principal believed that this consensus could be structured through curriculum mapping, grade-level teams and teacher observation informed by the intended goals of the classroom teacher. The grade level teams, the principal describes, are "very, very important":

> I made a decision to spend … more time with grade level teams.
> So, asking them 'What are kids learning?, how do you know?,
> what is the evidence?' and it can be student work projects, it can
> be results of tests, whatever, but just asking people about what
> evidence there is and then what are you doing for kids that need
> intervention because they are performing really high or really low
> … I told them from the very beginning it really wasn't about me
> there was just one low accountability; make sure you're really
> having these conversations about student work. I'm focusing
> much more on those questions and the context of grade level
> meetings. (Liberty principal)

The principal seeks to develop teacher knowledge and skills by modeling the kinds of inquiry practices she sees as important for data-driven instructional improvement at grade-level team meetings. She expects teachers to use their judgment to develop the relevant information to guide day-to-day instructional improvement and believes that encouraging teachers to identify, collect, and design interventions as well as to reflect on classroom-level data will result in a new kind of data-driven professional. For the most part, Liberty teachers appreciated the respect and support they received and rose to the challenge. Because the leaders at Liberty encouraged teachers to develop the instructional program based on their judgment, the collaborative relationships between and among teachers,

including data-driven decision making, are largely opportunistic and a result of teacher initiative.

The leaders at Community School had no qualms about promoting a school-wide instructional model. Early in her tenure, the Community School principal identified the classroom-to-classroom variability in the curriculum as the critical cause of the school's poor test scores. According to the principal:

> I had the reading resource teacher survey the staff, and they were basically all doing different things. There was no consistency within the building—we had wonderful staff, great teachers, hard working individuals, lovely school, great environment, caring community, but there wasn't any consistency with curriculum

She formed curriculum committee of teachers and staff to decide on an instructional program that would be implemented across the school. The Community School adopted the Direct Instruction (DI) curriculum and obtained a Comprehensive School Reform (CSR) grant to reorganize the school around DI.

> … [W]e basically developed an investigative committee and we went out to various schools, and they came back with a great interest in the Direct Instruction curriculum because they saw it in another school. (Community principal)

The principal believed that DI was important not only to improve instruction but also to bring staff together and share a common language around this unifying program.

We call this approach to instructional leadership *prescriptive*. Instead of granting teachers the discretion to develop individualized learning classroom environments as a path instructional improvement, the leaders at Community school adopted a school-wide curricular program to direct instructional decisions in the classroom. This is not to say that the leaders ignored the will of teachers in the school. The Community principal organized a school-wide process to choose a program and relied on the judgment of teachers to select and implement a program that could guide their work. The selection and implementation process was consensual rather than autocratic.

The DI program focused on reading, mathematics, and academically struggling students (the core areas of accountability scrutiny at the time). It provided training opportunities and coaching for teachers and staff. According to one lower grade teacher:

> There have been formal discussions taking place in terms of resources and certainly the DI curriculum and trainings. There's been lots and lots of trainings that has been available to take advantage of in terms of how to use DI. There's literacy coach coming in to do that. So there's been a lot of that kind of resource aimed at trying to improve the delivery [teaching] so that the kids will learn better and more at their speed. (Community lower grade teacher)

Adopting a common instructional program coordinated resources for improving teaching toward a shared goal of program implementation. Instead of posing the instructional challenge for each teacher to solve individually, Community established a collective approach that focused teacher efforts on implementing a known solution. Leaders at Community were involved in each step of the problem-solving process. The school psychologist explained how the administrators and support staff (who she refers to as "everyone") share the responsibility with the teachers: "[We] make a plan for an intervention and decide who's doing what pieces of the plan, and trying not to give the teacher the whole responsibility and really make sure that everyone shares in the responsibility."

This collaboration between Community school leaders and classroom teachers is demonstrated by the information network of formative assessment worksheets transferred classrooms to the school's literacy coach, who reviews the worksheets and synthesizes the information to provide feedback to the classroom teachers and the principal as necessary. As the principal explains:

> We've learned how to look at that data and use it to help guide us. Having a literacy coach is really good too, and she's really good at compiling that data, and she's the one person, quite honestly, where all these worksheets go to. She takes it, she looks at it, if again there's any red flags it's brought to my attention and I'll address it, or then on a monthly basis it's put together as far as an overall, which each classroom, which each group, how they're improving, where they're going, are they making enough gains. I look at that and we move forward. What do we need to focus on this month? (Community principal)

By following the worksheet information trail, we found that the literacy coach assumed responsibility for making sense of formative student assessments. Rather than setting questions for the teachers and letting them

figure out an appropriate response, the coach physically takes the information and provides an interpretation of the results (to be sure, she also performs a monitoring function for the principal). No analogous function was performed by the leaders at Liberty School.

Advice and Support Social Networks in Prescriptive and Discretionary Settings

Our analysis of the social network data corroborated the differences between the Liberty and Community school approach to instructional leadership found in the qualitative data. We focused on the density and centralization of the advice/support networks and the network position (degree centrality) of key actors in order to illustrate how the teachers in the two schools have different levels of access to people with data analysis expertise.

    The density and centralization of the teacher advice/support networks in the two schools are reported in Table 3. Density represents the proportion of observed ties to the number of ties that could potentially be present (Wasserman & Faust, 1994) and offers insight into "such phenomenon as the speed at which information diffuses among the nodes, and the extent to which actors have high levels of social capital and/or social constraint" (Hanneman & Riddle, 2005). Network centralization ranges from 0 to 100%; the index will equal 0 when no individual is more central than any other, and it will equal 100% when a single actor "completely dominates the network with respect to centrality" (Freeman, 1979, p. 228). A low network centralization suggests a diffused network, whereas a high network centralization suggests the existence of one or more specialized roles—either formal or informal—in that domain within the school. The "All domains" row combines all of the questions into a single network, and the subsequent rows treat each question separately.

Table 3
Advice/Support Network Density and Centralization by Domain and School

| | Liberty School | | Community School | |
	Density	Centralization (%)	Density	Centralization (%)
All domains	.05	12	.08	23
Reading	.02	25	.04	46
Writing	.01	21	.03	35
Mathematics	.01	17	.02	35
Science	.01	23	.01	32
Struggling students	.02	12	.04	30
Student behavior	.02	24	.04	46

Note.—Network size at Liberty = 74 and Community = 71.

We expected that the discretionary approach adopted by the leaders at Liberty school would result in a decentralized network and that the prescriptive approach at Community would result in more centralized networks in which leaders would be regarded by educators as key actors in the instructional process. With the exception of the science domain, the Community School advice/support networks are somewhat denser (.08 vs. .05) than the Liberty School networks, and as we expected they are also much more centralized[7]. Liberty has a centralization value of 12% and Community has a centralization value of 23%, suggesting that the overall network at Community School is almost twice as centralized as the network in Liberty School. Moreover, centralization values for individual domains are consistently twice as high in Community School as in Liberty School.

We also investigated the centrality of individuals or groups of individuals in the schools (Table 4). Individual/ego degree centrality represents the number of other individuals to which a given person is directly connected (Freeman, 1979)[8]. In both schools, the literacy coaches had the highest normalized degree centrality of any individual in the network, but the Community School's coach had a degree centrality of 26 compared to 13 for the Liberty School coach. The second most central figure at the Community School was the DI program implementer; there was no equivalent role at Liberty School. As one might expect from the discretionary leadership

approach, three of the next five most central staff members at Liberty School were teachers, whereas at the prescriptive Community School only one of the next five most central staff members was a teacher. Although neither school would be characterized as principal-centric ("literacy coach-centric" would be more accurate), the principal was the sixth-most central individual at Community School and the eleventh-most central individual at Liberty School.

Table 4

Centrality Comparison between Liberty and Community across Advice/Support Networks

	Liberty School	Community School
Ranking and individaul *degree* centrality of most central role[a]		
1	Literacy coach (13.0)	Literacy coach (26.4)
2	Assistant principal (13.0)	Assistant principal (23.6)
3	Reading specialist (12.3)	DI implementer (22.1)
4	Teacher (11.6)	Psychologist (18.6)
5	Teacher (9.6)	Teacher (16.4)
6	Teacher (9.6)	Principal (13.6)
…		
Average *indegree* centrality between teacher and leaders / support staff[a]		
Teacher[b]	5.2	7.8
Administrator and support staff[c]	12.2[*]	26.7[*]

Note.—[a](In)degree centrality measures were calculated based on the cross domain network. [b]$N_{Liberty}$ = 30, $N_{Liberty}$ = 28. [c]$N_{Liberty}$ = 10, $N_{Liberty}$ = 9. [*]$p < .05$.

Given that there is a difference in the overall network structure (i.e., density and centralization) between Liberty (discretionary) and Community (prescriptive) and that the order of the most central roles (degree centrality) in both schools meets the general expectations of the corresponding leadership approach, a more in-depth look into the leadership practice

between teachers and school administrators and support staff would help unpack the effects of these approaches to instructional leadership on social capital within the school. We calculated the indegree centrality to represent how connected an individual was by others to understand how individual's expertise is recognized by other network members. Table 4 presents the mean normalized indegree centralities of teachers and administrators and support staff across six domains at both Liberty and Community schools. The mean normalized indegree centrality among classroom teachers in Community was modestly higher than in Liberty (7.8 vs. 5.2) and no significant difference was found between Liberty and Community. However, the mean normalized indegree centrality among administrators and support was significantly higher in Community than in Liberty (26.7 vs. 12.2; t = -3.15, p < .05). While teachers were sought by 5-8% of their colleagues for advice/support in both schools, the administrators and support staff at Community played a much more prominent role in the school professional network in providing advice and support.

The centrality of the literacy coach and the DI program implementer at Community reflected a distributed information leadership strategy. Teachers at Community collected data on student performance and submitted it weekly to the literacy coach, who then compiled the data and reviewed it, a process the principal refers to as "funneling" the data. The principal explained how "we wanted to be looking at that data weekly so that we wouldn't have to go four weeks before we realized there was a problem with a classroom teacher or what was happening in that classroom." The data—at least for literacy—are consolidated by the literacy coach, and the principal can potentially review the performance of any class at any time. The teachers "offload" their data tasks to the literacy coach, who relieves them of the responsibility of making sense of the information.

The DI program implementer at Community—another centrally located individual—reviews data on a monthly basis and creates a "Critical Index" for the principal's review. The principal offers an example of how the monthly review of the Critical Index highlighted lack of student progress in a particular curricular area in a group of classrooms, which led to a series of classroom visits, consultation with additional support staff, and meetings with the teachers in which she encouraged them to "step it up a bit." Managing the weekly worksheets and monthly Critical Index is an intensive analysis process for school leaders. At Community School, these tasks are

performed by leadership team members whose regular engagement with teachers is reflected in the network centrality measures.

The leadership strategy around data collection and review processes looks quite different at Liberty School. When asked about the data reviewed at Liberty, the principal referred to a district climate survey and student promotion reports, the annual state assessment, and report cards. She admits, however, that the Liberty staff had not "figured out" how to "aggregate" report card or promotional information to discuss them as a school, and that "although some schools are quite systematic about it… I don't think we have been as systematic, and that's a place that we are moving." Liberty is a place which responds to teacher initiative, as the principal describes: "Other times the teachers will get together and they'll know of a program and they will approach me and say, 'Can we implement this?' and I say 'Go for it.'" Liberty's lack of a systematic curriculum initiative encourages teachers to use their best judgment in arranging classroom resources and engaging in instruction. This dispersed approach to the instructional program makes it difficult for leaders to coordinate data discussions around common practices.

In sum, the contrast between the discretionary leadership approach at Liberty School and the prescriptive leadership at Community School helps explain the variation in whole network patterns and aggregate centrality measures. Liberty's emphasis on promoting teacher discretion as the core mechanism of instructional improvement results in a diffused advice/support network structure in which teachers individually seek help from various resources, including one another. Community, on the other hand, adopted a prescriptive approach that provides a common focus for data collection and analysis and that results in higher levels of (in)degree centrality for designated data leaders. Teachers at Community seek advice and support from these leaders on instructional matters.

Cross-Domain Network Variations

In this section, we compare the advice/support network structures across six domains to show how leadership priorities shaped teacher interactions around specific practices. A key aspect of distributed leadership is to understand how leaders create structures that support certain types of

professional interactions; these interactions constitute professional networks that address particular tasks. We examine how teachers engage in reform-related professional interactions, and whether the pattern of interactions in each network corresponds with leadership priorities and initiatives.

We start with the advice/support networks for reading and writing (Table 5). Reading/writing is a district-wide mandated priority, and both schools have dedicated staff to support literacy instruction. Both schools have very similar sociograms, showing two centralized individuals (the literacy coach and reading specialist at Liberty; the literacy coach and DI program implementer at Community) who assist many teachers. Some teachers at Liberty School exercise their discretion at Liberty School to call upon their colleagues as well.

Table 5

Instructional Advice/Support Networks between Liberty and Community

Liberty School	Community School
Reading — Density: .02, Centralization: 25	Reading — Density: .04, Centralization: 46
Writing — Density: .01, Centralization: 21	Writing — Density: .03, Centralization: 35

Liberty School	Community School

Mathematics

Density: .01
Centralization: 17

Mathematics

Density: .02
Centralization: 35

Science

Density: .01
Centralization: 23

Science

Density: .01
Centralization: 32
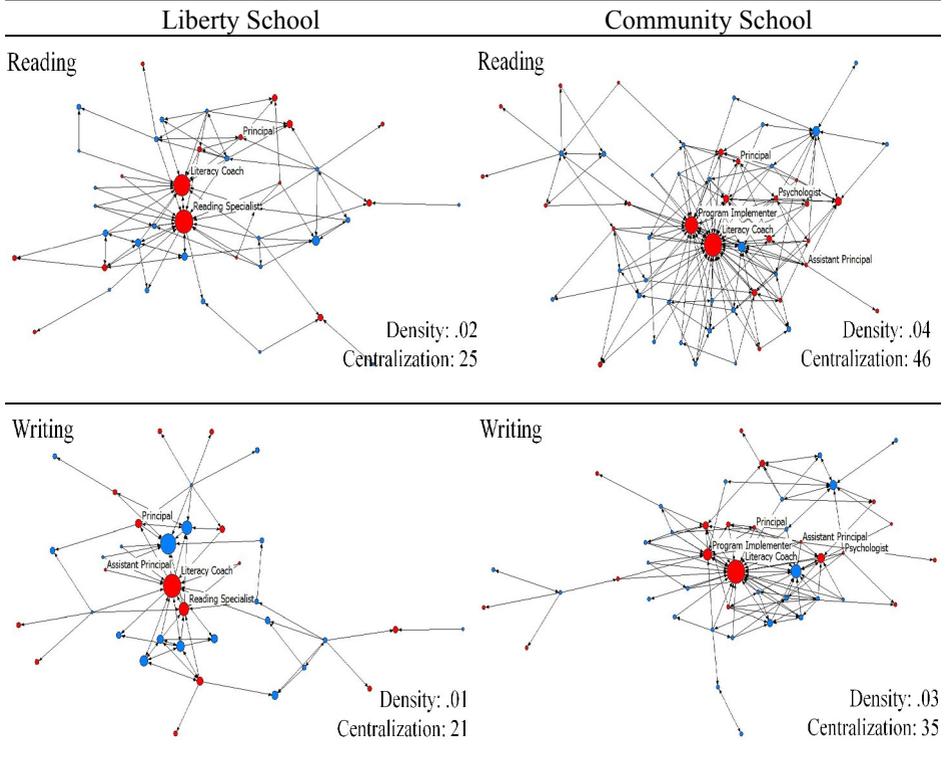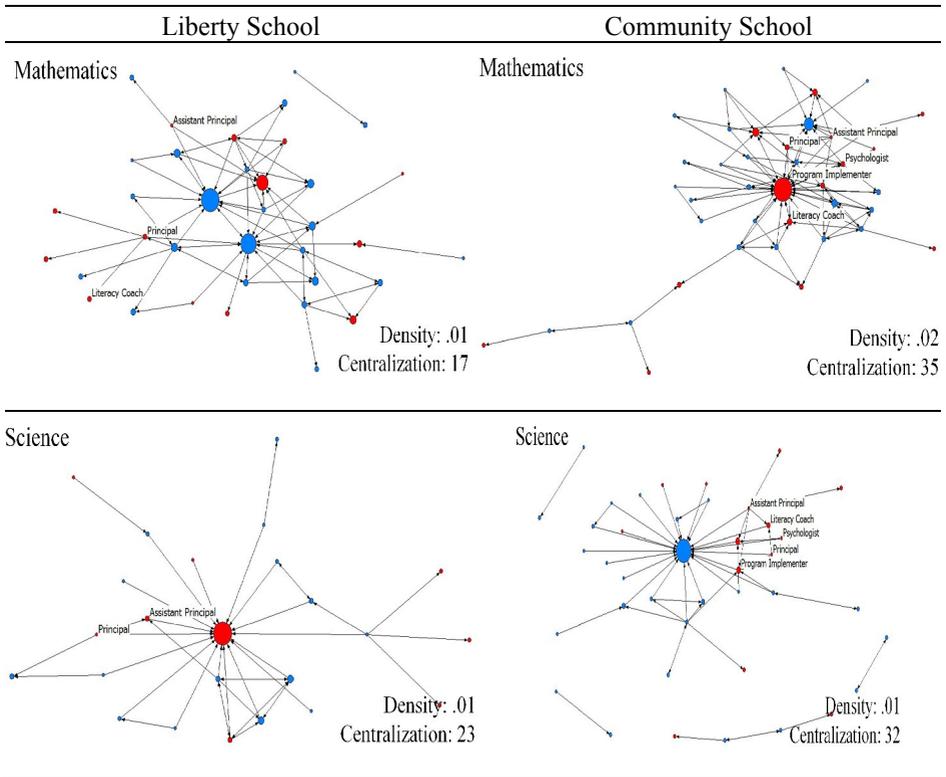
Note.—In all social network diagrams, the nodes represent individual school members and lines represent the exchange of advice/support ties between actors in each domain. The nodes are colored by role: blue/teacher and red/administrators and support staff; sized by indegree centrality: the larger the node, the more an individual receives advice/support ties from others. Node labels indicate key figures (e.g., principal, coach, or specialist, etc.) in each of the maps that pertain to the understanding of leadership priorities in the current study. Isolates are removed from the networks to better illustrate the active actors for each map. Network centralization presents in the form of percentage (%).

Compare these networks to those for mathematics, which is also a district-wide priority. At Liberty School, two classroom teachers are nominated as central individuals and Community School has only one centralized individual - the same DI program implementer in the literacy networks who creates the Critical Index. Liberty School designated "teacher

leaders" for mathematics at the primary and middle school levels, and primary and middle school teachers turn to them respectively. These teacher leaders led annual analyses of the state assessment data during a professional development day. However, teachers reported that this yearly event did not provide sufficient and ongoing data guidance to address daily instructional needs.

At Community School, the DI program implementer describes her division of labor with the literacy coach: "[The literacy coach] is really the reading and the language DI monitor, and I do the math, and then the upper grades we kind of share." Between these two individuals, the core accountability areas are addressed for all teachers. The centrality of the two teacher leaders in Liberty School reflects the teacher autonomy apparent in the discretionary model, but these teachers were not as readily available to their peers as the DI program implementer is at Community School.

The network structure with respect to science advice/support reflects its lower emphasis and status. As the principal of Liberty put it, "I think everyone understands that reading and math are coming first right now" (the principal at Community expressed a similar sentiment). Similarly, a teacher at Community asserted "if something is going to get cut, it's going to be science or social studies because the emphasis is on reading and math at this point of time." As a result, the science networks at both schools were sparse (.01 density for both). In the absence of clearly defined roles and leadership attention, idiosyncratic networks coalesced around individuals at each school by virtue of their individual initiative rather than by design: a classroom teacher at Community and a science instructional aide at Liberty.

The contrast between the two schools' leadership approaches is most apparent in the network structure regarding advice/support for academically struggling students (Table 6). Both schools devote a considerable attention to addressing the needs of struggling students, as shown by highest density across all networks at each school (.04 at Community and .02 at Liberty). At Liberty School, classroom teachers turn to a cluster of special educators (not prominent in any other networks) for assists in students who struggle academically (centralization of 12%). Notably, the two individuals who could help with literacy needs of students—the literacy coach and reading specialist—are not prominent in this network at Liberty.

Unlike Liberty, in Community School the same individuals who have appeared in the literacy and mathematics networks—the literacy coach and

the DI program implementer—appear centrally again in this network, joined conspicuously by the school psychologist (centralization of 30%). These three educators are members of the Community problem-solving team, the formal structure designed by school leaders to collaboratively address student learning and behavior issues. Liberty school also has problem-solving teams, but those members do not appear to be as central to professional community networks as they are at Community School. Teachers at Liberty seek help from specialists rather than its problem-solving team to address the needs of academically struggling students, but at Community these specialists include not only special educators but also those who also assist them with progress monitoring in literacy and mathematics.

Table 6

Non-Instructional Advice/Support Networks between Liberty and Community

Liberty School	Community School
Struggling Student	Struggling Student
Density: .02 Centralization: 12	Density: .04 Centralization: 30
Student Behavior	Student Behavior
Density: .02 Centralization: 24	Density: .04 Centralization: 46
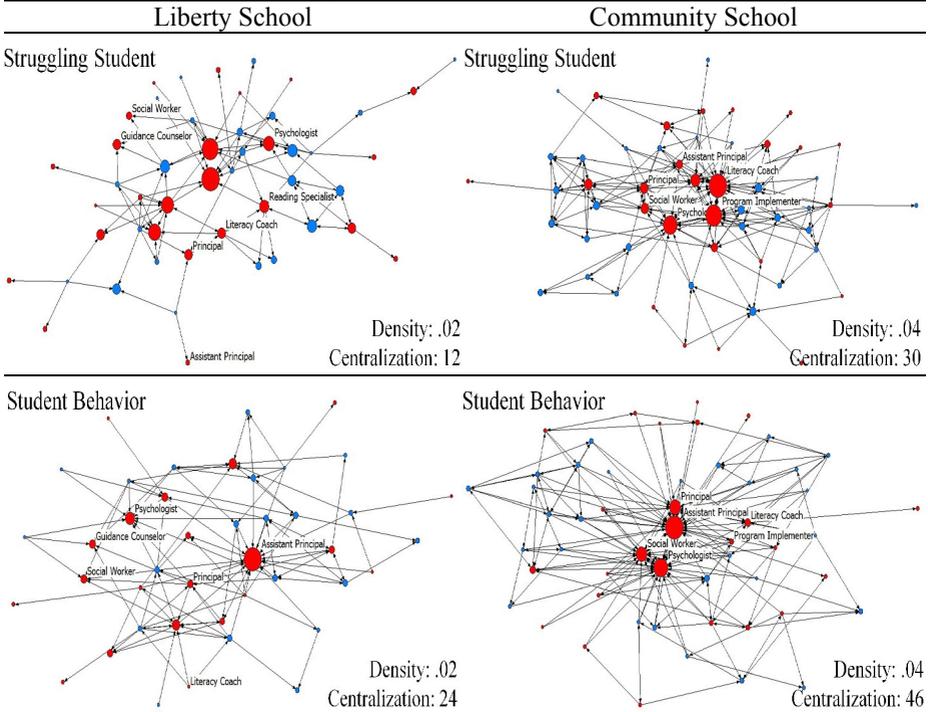
Note.—See Table 5 for detailed information.

Similarly, we observe in Community School an overlap between the academically struggling network and the advice/support network around student behavior problems. The student behavior network has the most dense and centralized structure (.02 density and 24% centralization at Liberty; .04 density and 46% centralization at Community). The assistant principal is prominent in this network in both schools, consistent with research on the role of assistant principals in primary and middle schools (Black, 1980; Matthews & Crow, 2003; Scoggins & Bishop, 1993; Smith, 1977; Weller & Weller, 2002). At Community School, however, the school psychologist, social worker, and principal—all members of the problem-solving team—are involved as well, and thus play a central role in both the academic and behavioral networks. Both the literacy coach and the DI program implementer bridge across reading, writing, mathematics, and academic needs. Single individuals who occupy central positions in multiple networks play an effective role in moving the flow of advice/support resources (Burt, 1992, 2000) necessary for aligned leadership priorities. Central individuals at Liberty vary across networks, and thus teachers receive less aligned support from central figures to address their instructional needs.

Discussion

Leadership and Design

The interview and social network data illustrated significant differences between these two otherwise similar schools. The theory of action for Liberty's discretionary model involves leaders who seek to support teacher discretion to set and solve instructional problems. The teachers are encouraged to build the curricular resources they see as suitable for meeting the needs of their students. The leaders organize and participate in meetings to reflect on school-wide data around student achievement and performance, and create student support services to address the needs of students who struggle – both behaviorally and academically. The leaders at Liberty leave decisions about instructional matters to teachers, who can collaborate as they see necessary, to meet the learning needs of students. The discretionary approach to instructional leadership created a strong feeling of professional

community at Liberty. However, from a data-driven leadership perspective, the separation of instructional from non-instructional support resulted in separate networks that served different organizational needs. If the role of data-driven decision making is to enable collective action about instruction, then the discretionary instructional leadership model adopted at Liberty struggled to create the kinds of professional community that could support data-driven improvement.

The leaders at Community school followed a prescriptive theory of action for instructional leadership. The prescriptive model began with the adoption of a comprehensive school reform model – Direct Instruction – that guided the decision-making of educators in the classroom. DI acted as an anchoring artifact to focus the work of educators across the school on the information that resulted from the intervention. The leaders at Community also adapted the problem-solving team as a structure to collect and process data about student learning as well as a consistent centralized consulting structure to provide services to teachers and students. From a data-driven decision making perspective, the Community leadership model separated the data-collection and interpretation function from the solution-implementation functions of the instructional system. The problem-solving team collected the daily DI reports to assemble the Critical Index reports, and then guided teachers on how to develop solutions for students in the classroom.

The enhanced capacity for data-driven practices for prescriptive instructional leadership runs counter to the current narrative about the relation of scripted curriculum to school culture and teacher professionalism. Prior research suggests that a prescriptive context of schooling tends to create a culture of deskilling where teaching practice is reduced to the implementation of scripted lessons (Apple, 1988; Barham, 1996; Little, 1990; Reilly, 1987). Prescriptive school models are criticized for eroding teacher professionalism by taking away authority over the curriculum (Mustafa & Cullingford, 2008; Pearson & Moomaw, 2005), and that teachers in schools with less authoritarian leadership models are more likely to view themselves as professionals (Tschannen-Moran, 2009). We did not find evidence of an association between centralized control and teacher isolation at Community School. The prescriptive leadership practices appeared to create densely connected and centralized professional interactions, with single actors bridging multiple networks to facilitate the flow of advice/support through the organization. The social resources took

the form of connections that provided teachers with ready access to the expertise of the centralized individuals to assist them with responding to student needs. While teachers in Community School had little control over the curriculum, they were able to use data in ways that gave them confidence in their classroom practices. Our data suggested the discretionary leadership model resulted in teachers feeling overwhelmed and less confident to meet the challenge of data-driven instruction, and, conversely, the prescriptive school provided teachers with access to an instructionally-focused problem-solving team that was engaged in all facets of instructional support. This allowed Community teachers greater access to resources they need to accomplish their work, which is a hallmark of professionalism (Horder, 2007; Swanson, 1995).

Organizational Cognitive Load and Design

We cannot, of course, use arguments grounded in two case studies to make general conclusions about the relative quality of instructional leadership practices to data use in schools, or the influence of comprehensive school reforms on data-driven school cultures. We can however, use the depth and the scope of these case studies to propose a model to understand the differences between the schools that emerged in our interviews and social network analyses. We propose to borrow a concept from cognitive science, cognitive load theory, to show how these approaches to instructional leadership differ. Cognitive load theory (e.g., Sweller, 1988) analyzes problem-solving by distinguishing the relation between short-term and long-term memory. Short-term memory is able to respond quickly to process novel situations, but expensive in terms of cognitive resources. Long-term memory is composed of knowledge structures, or schemas, derived from experiences that allow us to turn novel events into recognizable situations. We have limited capacity for short-term memory, but nearly unlimited cognitive capacity to develop schemas. Cognitive load theory, when applied to instructional design, promotes the development of relevant schemas for complex problem-solving by structuring complex problem-solving tasks into chunks that off-load the pressure on working memory resulting in a more efficient use of scarce cognitive resources.

How does cognitive load theory help us distinguish between the discretionary leadership at Liberty school from the prescriptive leadership at

Community?   From an organizational perspective, we can consider the *discretion* of individual actors in responding to novel situations as a rough analog to short-term memory, and organizational *routines* as analogous to the schema of long-term memory. Several key insights from cognitive load theory when applied to instructional design allow us to consider the two models of instructional leadership as distinctive approaches to the design of data-driven learning environments for teachers.

- First, from an instructional design perspective, leaders are responsible for *designing* socio-technical systems for the educators in their building. The challenges of data-driven decision making in schools include collecting the appropriate range of information, deliberating on how to transform the data into action, and reflecting on (then refining) the quality of the resulting action (c.f., Halverson et al., 2007).
- Second, leaders design data-driven learning environments by *chunking tasks* in ways that off-load the cognitive load of discretion by creating legitimate routines that can amplify the abilities of educators to handle novel situations. This chunking process breaks complex cognitive tasks into pieces that allow learners to focus attention on the tasks at hand rather than on the overall process. Organizational chunking means arranging complex tasks so that local discretionary action can be informed, but not overwhelmed, by the information faced by practitioners in the context of practice.
- A third design principle follows from the first two. Leaders can purposively design systems that can distribute cognitive load to make certain individuals central to organizational information network. Designing the information flow can create discrete responsibilities in cases where organizations need parallel and redundant networks; or alternatively the leaders can make the same individuals central to several information networks to create cross-disciplinary resource networks.

These insights into the design of information systems can shed light on the differences between instructional leadership choices at Liberty and Community. The leaders at Community School chunked the task of data-driven instruction into several parts. First, leaders and educators chose a comprehensive school reform model to anchor the instructional reform process. DI was a data-rich school-wide program that served as a frame of reference for educators at Community by narrowing the range of information for that were regarded as relevant for collection, reflection and action.

Second, leaders adapted the district-wide problem-solving team structure to serve as the information processing hub for the school[9]. The problem-solving team, composed of the principal, the assistant principal, the school psychologist, the literacy coach, the special education and the DI coordinator, collected daily DI reports from the teachers and made sense of where the instructional program was falling short in the classroom. This adaptation of the problem-solving team's function created an organizational routine that off-loaded the data interpretation task from teachers to school leaders. Third, teachers then implemented the decisions of the problem-solving team in their classrooms. Subsequent DI reports, circulated back to the problem-solving team, provided the ground for conversations about the degree to which the suggested changes in instructional practices were reflected in outcome data. Separating the data interpretation from implementation stages at Community had effects on the structure/pattern of professional networks of the school. Separating these functions created legitimate opportunities for teachers and leaders to interact around instructional issues, and placed leaders in the middle of both the school-wide and the classroom-level discussions about data and teaching. Further, the integration of daily instructional practice data into the work of the cross-disciplinary problem-solving team professionals in the school created more integrated networks of advice/support for educators in the schools. Special educators and assistant principals shared data reflection and decision-making tasks with the rest of the problem-solving team, and were thus provided opportunities to be recognized by teachers as legitimate sources of information about instructional and student support issues.

Liberty chunked the task of data-driven instruction differently. They decided against adopting a common program for instruction in favor of cultivating teacher ability to design and implement instructional programs customized to each classroom. This decision resulted in practices that stretched the capacity of the staff to use data throughout the school. Leaders designed and engaged in school-wide data reflection and interpretation activities, then, critically, relied on teacher discretion to both collect the appropriate information about daily classroom teaching and learning *and* to create opportunities for teachers to collaborate on instructional change. Further, the data practices in the schools were fragmented into regular classroom and special education networks. While teachers were responsible for generating and reflecting on classroom-level data, special educators were

responsible for diagnosing and designing interventions at the student level. Unlike at Community, the Liberty problem-solving teams were seen as special education, not general education, structures. One Liberty teacher noted:

> When we were first trained in problem-solving, we were unfortunately trained from more of a special education point of view instead of the overall school approach and so we're still struggling to get everyone looking at how we deal with problems and that method because there's still people who think that its special ed—it's not a way of how we work in the school so it's something that we're still learning how to do. (Liberty upper grade teacher)

The identification of problem-solving teams with special education created separate discourses about data for classroom teaching and special educators, and neither was well-integrated into the school-wide discourse on disaggregating achievement data. While special educators served as central hubs in Liberty's struggling student network, they were frustrated by their inability to discuss their data-related practices with teachers at Liberty:

> It was very frustrating because I think "here's this great data and we're not using it." I said "Let's look at where the kids are falling apart on the test . . ." There was a small [teacher] committee that looked at it (last year). They looked at the math test . . . they discovered a pattern which I had been aware of for a number of years. (Liberty special education teacher)

The discretionary instructional leadership practices at Liberty resulted in silos of professional capacity unable to form consensus around relevant data and make it available to school staff in order to improve instruction.

Conclusion

Advocates and policymakers of systemic reform and data-driven accountability practices argue that schools must develop the capacity to transform student learning data into improved instructional practices (Datnow, Park, & Wohlstetter, 2007; Lachat & Smith, 2005; Petrides & Nodine, 2005; US DOE, 2009). From this perspective, since the system outcome data takes the form of student test scores, then the aim of system improvement ought to focus on the school capacity to use data to raise test scores for as many students as possible. While we cannot claim that the adoption of a comprehensive school reform model is a necessary condition

for improving test scores, we can say that the DI program in the Community School case provided a good example of how a shared curriculum narrowed the range of actionable data for a school community, and that the problem-solving team allowed school leaders to play a central role in professional networks for data-driven decision making. Advocates of teacher autonomy might argue, however, that test score data capture only a narrow range of valued outcomes for public school students, and that the orchestration of a system that turns teachers into the implementers of other people's decisions robs teachers of the kinds of discretion critical for recognizing and acting upon the real range of student learning needs (Anderson, 1987; McGrath, 2000; Simon, 1987; Stacey, 2013; Webb, Briscoe, & Mussman, 2009). From the discretionary leadership perspective, the prescriptive model not only reduces the cognitive load of Community teachers, it leaves them deskilled and unable to teach unless provided with advice and a script.

Our cases are unable to resolve the differences between these two politically volatile and contrasting views on instructional leadership. We can though, draw design implications from the two approaches to instructional leadership. First, adopting a focal artifact (Halverson, 2010a, 2010b), such as a comprehensive school reform program, can define what counts as actionable data across a school. This focal artifact does not need to be a scripted curriculum. In fact, the key feature of the adoption of a focal artifact seems to be the collaborative process of selecting and implementing it. Researchers have studied how interventions as diverse as project-based science (Krajcik, Czerniak, & Berger, 2002), collaborative curriculum design (Reiser, Spillane, Steinmuller, Sorsa, Carney, & Kyza, 2000) and new media based participatory cultures (Jenkins, Purushotma, Clinton, Weigel, & Robison, 2007) can create dynamic, data-driven communities around teaching and learning practices. At Community School, the collaborative process to select DI as the focal artifact resulted from professional interaction across the school; the adoption of DI led teachers to visit other schools, collaboratively design information pathways, and team meetings to monitor and refine implementation.

The second design lesson addresses the design of cross-school, multidisciplinary professional communities. Professional communities thrive when members rely upon one another for help with the core tasks of the organization (Louis, 2006). This reliance, characterized as relational trust (Bryk & Schneider, 2002) develops when professionals ask one another

for advice about the problems of practice, and are successfully advised. In some schools, such as Liberty, leaders may design professional networks around instruction but are left out of them. Community School, however, made key design decisions to engage leaders in the school instructional networks. By separating the data interpretation from the implementation process, Community school leaders made themselves consultants for teachers, and thus key members of the instructional networks. Focusing data interpretation in the problem-solving team led leaders to collaborate with one another on solutions for the classroom, which resulted in cross-disciplinary perspectives on instructional issues. The challenge of interpreting the data for action in the classroom brought the principal, assistant principal, school psychologist, literacy coach and special educators together as resources on which teachers could rely for academic and behavioral matters. The cognitive load framework thus helps identify how the task of data interpretation and implementation was structured by the two schools, and how leaders can use the design lessons of these cases to structure data-driven decision-making processes in their schools.

Our work sheds light on the existing literature around data-driven instruction and distributed leadership and further describes a critical phenomenon regarding teachers' confidence in coping with achievement data between these different leadership models. As most school reform efforts only focus on the technical aspect of educational improvement (e.g., adopting new strategies in practices, hours of professional development, etc.), these efforts often neglect the local design of structural (e.g., network resources in support of corresponding domains) and relational (e.g., consistent professional ties to useful resources) resources that may develop social capital for managing and using data for instruction. In pursuit of successful reform around teaching and learning outcomes, education leaders need to design data-driven instructional systems that provide ready access to professionals who can work with teachers to meet accountability demands.

Notes

[1] For several perspectives on the relation of data-driven accountability practices and school leadership, see Hamilton, Halverson, Jackson, Mandinach, Supovitz, & Wayman, 2009; Le Floch, Martinez, O'Day, Stecher, Taylor, & Cook, 2007; Marsh, Pane, & Hamilton, 2006; Stecher, Epstein, Hamilton, Marsh, Robyn, McCombs, Russell, & Naftel, 2008.

[2] The school names are pseudonyms.

[3] The sampling frame included all full-time licensed staff members employed at the school in the spring of 2007. The sample includes teachers, librarians, full-time special educators, counselors, social workers, administrators, and the like, but does not include many of the forms of employment within a school, such as educational assistants, part-time credentialed teachers (e.g., itinerant fine arts teachers), volunteers, or clerical staff.

[4] The teachers could also write in individuals who were not on the provided roster; write-in nominations generally consisted of school district staff or teachers at other schools. For each of the six domains, teachers could nominate up to nine individuals (seven fixed, two write-in). The responses were not valued, but rather were indications of whether the respondent sought advice and support from another staff member in one of the six areas, so these data represent the presence of a tie but not its intensity.

[5] Two constructs with respect to data-driven instruction were created using principal component analysis and maximum likelihood analysis. The first construct—School Leadership—consists of 11 items, explaining 65% of the total variance. The second construct—Use of Achievement Data—contains 9 items, explaining 62% of the total variance. Scale items and factor loadings are reported in Appendix.

[6] The scale we reported here refers to "evaluating progress" that contains 3 items. We asked participants at their school to assess the number of staff members who: "Have the skills or capacity to use data in a productive way?," "Feel comfortable discussing data?," and "Feel comfortable discussing data?" on a five-point scale from 1 (none) to 5 (75-100%).

[7] Teachers could nominate up to nine others, so the maximum density we could observe in each school is approximately 9/73 or 0.12. If the response rate to Liberty School had been as high as the response rate to Community School, we believe that the differences between the two networks—especially with respect to their centralization—would remain apparent.

[8] Since the networks are of different sizes, we report normalized values in order to compare across the networks (Wasserman & Faust, 1994).

[9] For more detail on the role of the problem-solving team in data-driven instructional practices, see Halverson & Thomas, 2007 and Thomas, 2008.

References

Anderson, L. W. (1987). The decline of teacher autonomy: tears or cheers? *International Review of Education*, 33, 357-373. doi: 10.1007/BF00615308

Apple, M. (1988). *Teachers & Textbooks: A Political Economy of Class & Gender Relations* Routledge & Kegan Paul: London.

Barham, E. (1996). Central control of the curriculum and teacher involvement in curriculum change. *Journal of Curriculum and Supervision*, 12, 29-36.

Black, A. B. (1980). Clarifying the role of the assistant principal. *NASSP Bulletin*, 64(436), 33-39.

Black, P., & Wiliam, D. (2010). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, *92*(1), 81-90.

Borgatti, S. P. (2002). *NetDraw: Graph visualization software*. Harvard: Analytic Technologies.

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *UCINET 6 for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Bryk, A.S. & Schneider, B. (2002) *Trust in schools: A core resource for improvement* New York, NY: Russel Sage Foundation.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Cambridge, MA: Harvard University Press.

Burt, R. S. (1997). A note on social capital and network content. *Social Networks*, *19*(4), 355-373. doi: 10.1016/S0378-8733(97)00003-8

Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior*, 22, 345-423. doi: 10.1016/S0191-3085(00)22009-1

Coburn, C. E., & Russell, J. L. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis*, 30, 203-235. doi: 10.3102/0162373708321829

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology,* 94, S95-S120. doi: 10.1086/228943

Daly, A. J. (2010). *Social network theory and educational change*. Cambridge MA, Harvard Education Press.

Daly, A. J. (2012). Data, dyads, and dissemination: Exploring data use and social networks in educational improvement. *Teachers College Record*. 114,11.

Daly, A. J., Liou, Y. H., Tran, N., Cornelissen, F., & Park, V. (2013). The rise of neurotics: Social networks, leadership, and efficacy in district reform. *Educational Administration Quarterly*. doi: 10.1177/0013161X13492795

Datnow, A., Park, V., & Wohlstetter, P. (2007). *Achieving with data: How high-performing school systems use data to improve instruction for elementary students*. Center on Educational Governance, University of Southern California.

Degenne, A., & Forsé, M. (1999). *Introducing social networks*. London, UK: Sage.

Elmore, R. (2000). Building a new structure for school leadership. *American Educator*, *23*(4), 6-13.

Elmore, R. F. (2005). Accountable leadership. Essays. *The Educational Forum*, 69, 134-142. doi: 10.1080/00131720508984677

Freeman, L. C. (1979). Centrality in social networks: conceptual clarification. *Social Networks*, 1, 215-239. doi: 10.1016/0378-8733(78)90021-7

Goertz, M. E., Olah, L. N., & Riggan, M. (2009). *From testing to teaching: The use of interim assessments in classroom instruction* (Research Report #65). Philadelphia: University of Pennsylvania, Consortium for Policy Research in Education.

Granovetter, M. S. (1982). The strength of weak ties: A network theory revisited. In P. V. Marsden and N. Lin (Eds.), *Social structure and network analysis* (pp. 105-130). Beverly Hills: Sage.

Gronn, P. (2002). Distributed leadership. In K. Leithwood & P. Hallinger (Eds.), *Second international handbook of educational leadership and administration* (pp. 653-696). Dordrecht, Netherlands: Kluwer. doi: 10.1007/978-94-010-0375-9_23

Halverson, R. (2003). Systems of practice: How leaders use artifacts to create professional community in schools. *Education Policy Analysis Archives*, *11*(37).

Halverson, R. (2005). What can K-12 school leaders learn from video games and gaming? *Innovate*, *1*(6). http://www.innovateonline.info/index.php?View=article&id=81

Halverson, R. (2010a). *Methods for accessing and assessing how school leaders improve teaching and learning*. Paper presented at the 2010 American Educational Research Association Annual Convention, Denver, CO.

Halverson, R. (2010b). School formative feedback systems. *Peabody Journal of Education*, 85, 130-146. doi: 10.1080/01619561003685270

Halverson, R., Grigg, J., Prichett, R., & Thomas, C. (2007). The new instructional leadership: Creating data-driven instructional systems in school. *Journal of School Leadership*, 17, 159-194.

Halverson, R. & Thomas, C. (2007). The roles and practices of student services staff as data-driven instructional leaders. In M. Mangin and S. Stoelinga (Eds.) *Instructional teachers leadership roles: Using research to inform and reform* (pp. 163-200). Teachers College Press: New York.

Hamilton, L., Halverson, R., Jackson, S., Mandinach, E., Supovitz, J., & Wayman, J. (2009). *Using student achievement data to support instructional decision making* (NCEE 2009-4067). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved February 1, 2011 from http://ies.ed.gov/ncee/wwc/publications/practiceguides/.

Hanneman, R. A., & Riddle, M. (2005). *Introduction to social network methods*. Riverside, CA: University of California, Riverside (published in digital form at http://faculty.ucr.edu/~hanneman/).

Horder, W. (2007). 'Reading' in professional practice: How social work practice assessors access knowledge and information. *British Journal of Social Work*, *37*(6), 1079-1094. doi: 10.1093/bjsw/bcl080

Ibarra, H., & Andrews, S. B. (1993). Power, social influence, and sense making: Effects of network centrality and proximity on employee perceptions. *Administrative Science Quarterly*, *38*, 277-303. doi: 10.2307/2393414

Inkpen, A. C., & Tsang, E. W. K. (2005). Social capital, networks, and knowledge transfer. *Academy of Management Review*, *30*(1), 146-165. doi: 10.5465/AMR.2005.15281445

Jenkins, H., Purushotma, R., Clinton, K., Weigel, M., & Robison, A. (2007). *Confronting the challenges of participatory culture: Media*

education for the 21st century. MacArthur Foundation Digital Media and Learning White Paper Series. Accessed October 15, 2010 at http://newmedialiteracies.org/files/ working/NMLWhitePaper.pdf

Jennings, J. (2012). The effects of accountability system design on teachers' use of test score data. *Teachers College Record*, *114*(11), 1-23.

Krajcik, J. S., Czerniak, C. M., & Berger, C. F. (2002). *Teaching science in elementary and middle school classrooms: A project-based approach* (2nd ed.). New York: McGraw Hill.

Lachat, .A., & Smith, S. (2005). Practices that support data use in urban high schools. *Journal of Education for Students Placed at Risk*, *10*(3), 333-349. doi: 10.1207/s15327671espr1003_7

Le Floch, K. C., Martinez, F., O'Day, J., Stecher, B., Taylor, J., & Cook, A. (2007). State and Local Implementation of the No Child Left Behind Act. *Volume III—Accountability under NCLB: Interim Report*. The U.S. Department of Education Web site: http://www.edgov/about/offices/list/opepd/ppss/reports.html.

Lin, N. (1999). Building a network theory of social capital, *Connections, 22(*1), 28-51.

Lin, N. (2001). *Social capital: A theory of social structure and action*. New York: Cambridge University Press. doi: 10.1017/CBO9780511815447

Lin, N. (2009). *Social capital: A theory of social structure and action*. New York, NY: Cambridge University Press.

Liou, Y., & Daly, A. J. (in press). Closer to learning: Social networks, trust, and professional communities. *Journal of School Leadership*.

Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record*, 91, 509-536.

Little, J. W. (2003). Inside teacher community: Representations of classroom practice. *Teachers College Record,* 105, 913–945. doi: 10.1111/1467-9620.00273

Little, J. W. (2012). Understanding data use practice among teachers: The contribution of micro-process studies. *American Journal of Education*, 118(2), 143-166. doi: 10.1086/663271

Louis, K. S. (2006). Changing the culture of schools: Professional community, organizational learning, and trust. *Journal of School Leadership 16*(4), 477-489.

Marsden. P. V., & Campbell, K. E. (1984). Measuring tie strength. *Social Forces*, 63, 482-501. doi: 10.1093/sf/63.2.482

Marsh, J. A., Pane, J. F., & Hamilton, L. S. (2006). *Making sense of data-driven decision making in education: Evidence from recent RAND research*. Santa Monica, Calif.: RAND Corporation, OP-170-EDU. Retrieved   from: http://www.rand.org/pubs/occasional_papers/OP170/

Matthews, L., & Crow, G. (2003). *Being and becoming a principal: Role conceptions for contemporary principals and assistant principals*. Boston, MA: Allyn and Bacon.

McGrath, I. (2000) Teacher autonomy. In B. Sinclair, I. McGrath and T. Lamb (eds.) *Learner autonomy, teacher autonomy: Future directions*. London: Longman.

Mustafa, M., & Cullingford, C. (2008). Teacher autonomy and centralized control: The case of textbooks. *International Journal of Educational Development*, 28, 81-88. doi: 10.1016/j.ijedudev.2007.07.003

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, 23, 242-266. doi: 10.5465/AMR.1998.533225

Pearson, L. C., & Moomaw, W. (2005). The relationship between teacher autonomy and stress, work satisfaction, empowerment, and professionalism. *Educational Research Quarterly 29*(1), 38-54.

Penuel, W., Riel, M., Krause, A., & Frank, K. (2009). Analyzing teachers' professional interactions in a school as social capital: A social network approach. *Teachers College Record*, *111*(1), 124-163.

Penuel, W. R., Sun, M., Frank, K. A., & Gallagher, H. A. (2012). Using social network analysis to study how collegial interactions can augment teacher learning from external professional development. *American Journal of Education*, *119*(1), 103-136. doi: 10.1086/667756

Petrides, L., & Nodine, T. (2005). *Anatomy of school system improvement: Performance-driven practices in urban school districts*. San Francisco, CA: Institute for the Study of Knowledge Management in Education and New Schools Venture Fund.

Putnam, R. D. (1993). *Making democracy work.*NJ: Princeton University Press, Princeton.

Putnam, R. D. (1995). Bowling alone: America's declining social capital. *Journal of Democracy*, 6, 65-78. doi: 10.1353/jod.1995.0002

Reilly, D. H. (1987). Centralization and control: Values and quality of education. *Education*, 107, 388-393.

Reiser, B. J., Spillane, J. P., Steinmuller, F., Sorsa, D., Carney, K. & Kyza, E. (2000) Investigating the Mutual Adaptation Process in Teachers' Design of Technology-Infused Curricula. In B. Fishman & S. O'Connor-Divelbiss (Eds.), *Proceedings of the Fourth International Conference of the Learning Sciences* (pp. 342-349). Mahwah, NJ: Erlbaum.

Scoggins, A., & Bishop, H. (1993, November). *A review of the literature regarding the roles and responsibilities of assistant principals*. Paper presented at the Annual Meeting of the Mid-South Educational Research Association, New Orleans, LA.

Scott, J. (2000). *Social network analysis (2nd Ed.)*. London: Sage Publications.

Simon, R. (1987). Empowerment as a pedagogy of possibility. *Language Arts*, 64, 370-382.

Smith, D. (1977). Assistant principal: With the title goes the glory. *Thrust for Education Leadership*, *6*(5).

Smylie, M., & Hart, A. (1999). School leadership for teacher learning and change: A human and social capital development perspective. In J. Murphy & K. S. Louis (Eds.), *Handbook of research on educational administratio*n. A project of the American Educational Research Association (2nd ed., pp. 421-441). San Francisco: Jossey-Bass.

Spillane, J. P.(2006) *Distributed leadership*. San Francisco, CA: Jossey-Bass.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2004). Towards a theory of leadership practice: A distributed perspective. *Journal of Curriculum Studies*, *36*(1), 3–34. doi: 10.1080/0022027032000106726

Spillane, J. P., Kim, C. M., & Frank, K. A. (2012). Instructional advice and information providing and receiving behavior in elementary schools: Exploring tie formation as a building block in social capital development. *American Educational Research Journal 49*(6), 1112-1145. doi: 10.3102/0002831212459339

Stacey, M. (2013). Teacher-led professional development: Empowering teachers as self-advocates. *The Georgia Social Study Journal*, *3*(1), 40-49.

Stanulis, R. N., Burrill, G., & Ames, K. T. (2007). Fitting in and learning to teach: Tensions in developing a vision for a university-based induction program for beginning teachers. *Teacher Education Quarterly*, *34*(3), 135-147.

Stecher, B. M., Epstein, S., Hamilton, L. S., Marsh, J. A., Robyn, A., McCombs, J. S., Russell, J., & Naftel, S. (2008). *Pain and gain: Implementing No Child Left Behind in three states, 2004-2006*. Santa Monica, CA: RAND Corporation, MG-784-NSF. Accessed October 9, 2009 at: http://www.rand.org/pubs/monographs/MG784/

Sun, M., Frank, K. A., Penuel, W. R., & Kim, C. M. (2013). How external institutions penetrate schools through formal and informal leaders. *Educational Administration Quarterly*, 1-35.

Supovitz, J., & Klein, V. (2003). *Mapping a course for improved student learning: How innovative schools systematically use student performance data to guide improvement*. Philadelphia: Consortium for Policy Research in Education.

Swanson, J. (1995). *Systemic reform in the professionalism of educators. Volume I: Findings and Conclusions. Studies of Education Reform*. Andover, MA: NETWORK, Inc.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257–285. doi: 10.1207/s15516709cog1202_4

Thomas, C. (2008). *Problem-solving teams and data-driven school leadership: A path toward the next generation of special education services*. Dissertation Abstracts International Section A, 68, 3245.

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal*, *44*(5), 996-1004.

Tsai, W. & Ghoshal, S. (1998). Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal*, *41*(4), 464-476. doi: 10.2307/257085

Tschannen-Moran, M. (2009). Fostering teacher professionalism: The role of professional orientation and trust. *Educational Administration Quarterly, 45,*   217-247. doi: 10.1177/0013161X08330501

Turner, E., & Coburn, C. (2012). Interventions to promote data use: An introduction. *Teachers College Record*, *114*(11), 1-13.

U.S. Department of Education (2009). *Race to the top program*. Retrieved from: http://www2.ed.gov/programs/racetothetop/executive-summary.pdf

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge, UK: Cambridge University Press. doi: 10.1017/CBO9780511815478

Webb, P., Briscoe, F. M., & Mussman, M. P. (2009). Preparing Teachers for the Neoliberal Panopticon. *Educational Foundations*, *23*(3-4), 3-18.

Weller, L., & Weller, S. (2002). *The assistant principal: Essentials for effective school leadership*. Thousand Oaks, CA US: Corwin Press.

Wenger, E. (1998). *Communities of practice: Learning, meanings, and identity*. New York: Cambridge University Press. doi: 10.1017/CBO9780511803932

Yin, R. K. (2009). *Case study research: Design and methods*. (4th Ed.). Thousand Oaks, CA: Sage Publications.

Young, V. M. (2006). Teachers' use of data: Loose coupling, agenda setting, and team norms. *American Journal of Education*, *112*(4), 521–548. doi: 10.1086/505058

Yi-Hwa Liou is a post-doctoral researcher in Education Studies at the University of California, San Diego

Jeffrey Grigg is a Ph.D. candidate in Sociology at the University of Wisconsin, Madison

Richard Halverson is a Professor in Educational Leadership and Policy Analysis at the University of Wisconsin, Madison

Contact Address: yihwa.liou@gmail.com

Appendix

Factor Loadings and Reliability in School Leadership and Use of Achievement Data

Item	Loading
School leadership	
Regular feedback (α = .80)	
The school has an effective/ongoing system for evaluating the progress toward its goals.	0.86
School leaders provide regular feedback to teachers about their teaching.	0.84
Teachers are able to diagnose and address student academic problems early.	0.74
There is a shared, school-wide commitment to improving student learning.	0.69
Test score priority (α = .74)	
Test score results helped me plan my instruction this year.	0.84
Test-score accountability has helped us focus on what's best for our students.	0.75
Improving test score results were a priority at my school this year.	0.74
Shared commitment (α = .66)	
Teachers respect other teachers who take the lead in school improvement efforts.	0.83
It's OK in this school to discuss student data with other teachers.	0.65
Parents often receive high-quality information about student progress.	0.52
Teachers use common assessments.	0.43
Use of achievement data	
Reviews useful data (α = .72)	
Our data analysis discussions result in concrete suggestions for action.	0.78
I feel that the time we spend reviewing data is well used.	0.78
I wish I could spend more time reviewing data with my colleagues.	0.73
I feel that the school reviews the right kinds of data to help me improve my teaching.	0.61

Item	Loading
State assessments ($\alpha = .71$)	
I use [state assessment] data to modify my instruction.	0.91
I have easy access to [state assessment] data.	0.83
Use of own data from PD and help from colleagues ($\alpha = .60$)	
My in-service professional development has adequately prepared me to use achievement data to improve instruction.	-0.78
I find the data I collect on my own to be more useful than [state assessment] data.	0.66
My colleagues have helped me to use achievement data to improve instruction.	-0.58