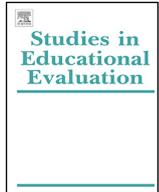




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# Developing collaborative data use through professional learning communities: Early lessons from Delaware

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### ABSTRACT

In 2010–2011 the Delaware Department of Education (DE DOE) mandated that all grade or subject area teachers have 90 min weekly to engage in professional learning communities (PLC) in which collaborative data use was the central activity. The purpose of this research is to learn from the early implementation experiences of four elementary schools in two districts, with particular attention to whether and how schools' implementation fostered collaborative use of data. Findings suggest the mandate resulted in the establishment of scheduled collaborative time and teachers' collaborative use of data in all schools. However, the nature of collaborative work and the ways in which data were employed varied in ways that relate to key school and district differences.

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### Introduction

Globally, educators face growing expectations to utilize data to improve instruction and need supports to achieve that goal. In the United States, these expectations are embodied in federal, state, and local educational policies. At the federal level, *No Child Left Behind* and *Race to the Top (RTTT)* reinforce the need for education agencies to collect and act upon various forms of data for accountability purposes.

States and local educational agencies have responded to these federal calls by increasing access to data through the development of data systems and tools and by supporting educators' use of data through the development of a range of data support interventions (Coburn & Turner, 2012; Marsh, 2012; Means, Padilla, DeBarger, & Bakia, 2009). In this paper, we explore one such response in order to better understand the potential for mandates to leverage data use.

As part of its RTTT funds, the Delaware Department of Education (DE DOE) mandated that all grade or subject area teachers have 90 min weekly to engage in professional learning communities (PLC) in which collaborative data use was the central activity. We begin by discussing the initiative's theory of action and supporting literature. Drawing on data from a mixed methods study of data

use in four schools and two districts, we then explore school and district implementation of the mandate and the nature and extent of collaborative data use developed across sites. Throughout these findings we attend to how schools and districts differ in their approach to the mandate and how those differences explain outcomes for teachers' collaborative use of data.

#### *The Delaware approach to data-informed PLCs*

The DE DOE was awarded funds through the 2010 RTTT competition. PLC time was specifically included to address the RTTT-required section on development of data systems to support instruction. PLCs were part of a larger strategy for increasing data-informed decision-making statewide. Other components, including RTTT funded Data Coaches, a new state longitudinal data system, and partnership with Harvard University's Strategic Data Project, were not fully implemented at the time of this study. However, it is important to note the state context of the study is one with strong commitment to the use of data to drive improvement and that PLC's are just one aspect of these efforts.

The DE DOE articulates its approach to PLCs through the RTTT plan,<sup>2</sup> a "hip pocket" reference,<sup>3</sup> and through ongoing support to

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<sup>2</sup> Available at [http://www.doe.k12.de.us/rttt/DE%20RTTT%20Narrative%20Final%20-%20100119\\_0116.pdf](http://www.doe.k12.de.us/rttt/DE%20RTTT%20Narrative%20Final%20-%20100119_0116.pdf).

<sup>3</sup> Available at [https://www.google.com/url?q=http://www.doe.k12.de.us/rttt/lea\\_pages/files/HipPocket\\_CPTR.pdf&sa=U&ei=gTn4UOitNMry2gWPulBw&ved=0CAcQF-jAA&client=internal-uds-cse&usg=AFQjCNGS7Kg2DLiDhLD6b3p35EP4R8gUyA](https://www.google.com/url?q=http://www.doe.k12.de.us/rttt/lea_pages/files/HipPocket_CPTR.pdf&sa=U&ei=gTn4UOitNMry2gWPulBw&ved=0CAcQF-jAA&client=internal-uds-cse&usg=AFQjCNGS7Kg2DLiDhLD6b3p35EP4R8gUyA).

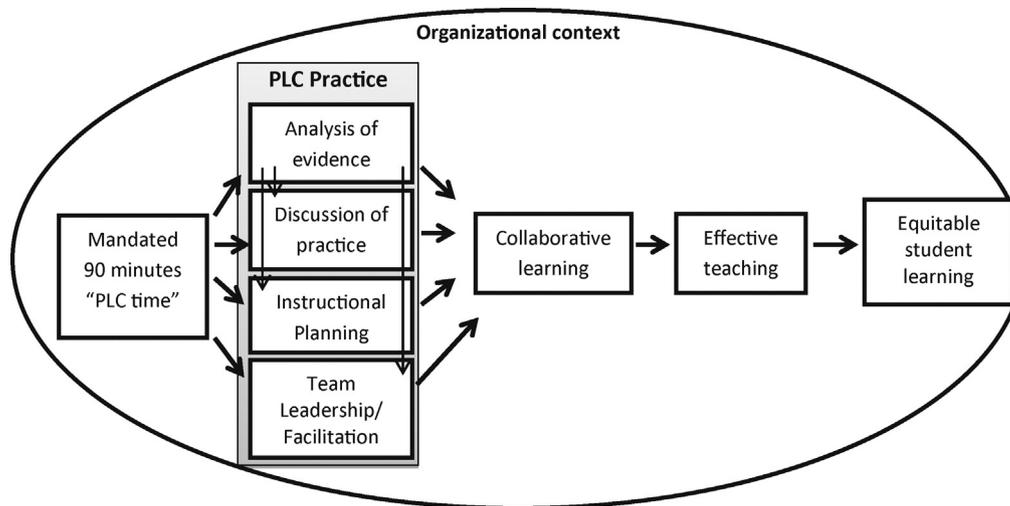


Fig. 1. The theory of action underlying the Delaware mandate.

LEAs. These resources frequently refer to four components of effective collaborative planning: analysis of evidence of student learning, discussion about teaching practice, instructional planning, and team leadership and facilitation.

Furthermore, DE DOE's definitions of "effective" teams emphasize the role of data in all four components: the use of multiple forms of assessment as evidence of student learning, analysis of evidence of what is and is not working in discussions of teaching practice, differentiated grouping and lessons accompanied by formative assessment during instructional planning, and development of leadership that is analytic, reflective and results oriented.

The initiative emphasizes the development of teachers' instructional capacity through the dual mechanisms of collaboration and data use. More specifically, the underlying logic of the state mandate holds that effective teaching is the "single most powerful lever to impact equitable student learning", and that collaborative learning time is a correspondingly powerful lever for improving teaching. Evidence of student learning – i.e. data – is a central tool in teachers' collaborative learning.

DE DoE documentation also acknowledges that the mandate alone will not foster the outcomes intended. Certain conditions are necessary for fostering effective collaborative planning time, including timely and relevant data provision; curricular and planning tools and resources; protected time for collaboration, and district culture of continuous learning and improvement. In addition, school and district leadership are expected to provide support and resources for the implementation of this mandate. Based on DE DoE documentation, we present Fig. 1 to illustrate the underlying theory of action, which, although not articulated explicitly, has a strong literature base to support it, drawn from research on both data use and PLCs.

#### Research evidence supporting data-informed PLCs

Research and practice supports the power of professional communities in implementing reform and sustaining instructional improvement (Hord, 1997; Kruse, Seashore Louis, & Bryk, 1994). Based on the early work of Rosenholtz (1989), McLaughlin and Talbert (1993), and Senge (1990) related to collective learning and learning organizations, PLCs were conceived as structured time for teacher learning. McLaughlin and Talbert (2006) explain, "Learning communities provide opportunities for reflection and problem solving that allow teachers to construct knowledge based on what they know about students' learning and evidence of their progress (p. 5)". With the press for increased accountability along with the

increased availability of student learning data, Little (2012) notes that schools and districts are adopting PLCs specifically organized for educators to discuss data as a mechanism for instructional improvement. This is not surprising as prescriptive PLC procedures frequently emphasize the role of data in reflective inquiry and practice (DuFour, DuFour, & Eaker, 2008; Van Lare & Brazier, 2012).

The theory of action underlying Delaware's mandate suggests that the required collaborative time will generate or improve teachers' use of data. Studies of data use indeed suggest that effective practice is often social in nature, (e.g., Datnow, Park, & Wohlstetter, 2007; Kerr, Marsh, Ikemoto, Darilek, & Barney, 2006; Lachat & Smith, 2005; Schildkamp & Kuiper, 2010; Wayman & Stringfield, 2006) and can result in better instructional decision-making and foster deeper use of data (Lachat & Smith, 2005; Supovitz, Merrill, & Conger, 2010; Young, 2006). Furthermore, most prescriptive models of data use incorporate substantial collaborative elements (Supovitz & Morrison, 2011).

#### Evidence of impact on student learning

While the literature bears out the theoretical importance of PLCs and data use for teacher learning, evidence of their impact on teacher learning, instruction, and student outcomes is more tenuous. A growing body of literature documents the production of teacher knowledge, particularly of student learning, as a result of evidence-based collaboration (Andrews & Lewis, 2007; Cosner, 2011b; Earl & Timperley, 2009). However, research also finds that teachers' coupling of this knowledge to instructional practice varies (Lasky, Schaffer, & Hopkins, 2009; Nabors-Olah, Lawrence, & Riggan, 2010; Timperley, 2009; Young, 2006). Vescio, Ross, and Adams (2008) report few studies documenting effects of PLCs on teacher practices, with only five specifying the change and most reporting teachers' claims about changing their practice. Coburn and Turner (2011) caution that changes in practice are not always positive, but may "game" the system, narrow the curriculum, or change practice superficially.

A small body of evidence supports the impact of PLC or data use on student learning. Vescio et al. (2008) find only eight studies that attempt to connect PLCs to student achievement while a meta-analysis of professional community and student achievement (Lomos, Hofman, & Bosker, 2011) finds only five with measurable effects on learning. There is similarly little evidence in research focusing on data use, with only a few studies making connections between data use, teacher practice and knowledge, and student learning (Christman et al., 2009; Fuchs, Fuchs, Karns, Hamlett, & Katz, 1999; Lai & McNaughton, 2009; Saunders, Goldenberg, &

Gallimore, 2009). In spite of the small numbers, evidence is consistently positive and supports the collaborative use of data to improve student learning.

#### *Influence of contextual factors*

While both research on professional community and data use suggest the power of collaboration around data as a lever of instructional improvement, research also suggests that the outcome is not automatic but rather is influenced by a number of contextual factors including resources, culture, and leadership (for a review of research-based components, see Mandinach & Jackson, 2012).

Research has identified the importance of structured time as critical for successful collaboration (Blanc et al., 2010; Coburn & Turner, 2011; Datnow et al., 2007; Halverson, Grigg, Prichett, & Thomas, 2007; Ikemoto & Marsh, 2007; Ingram, Louis, & Schroeder, 2004; Kerr et al., 2006; Sharkey & Murnane, 2006; Supovitz, 2002; Supovitz & Klein, 2003; Wayman, 2005). Other resources shown to impact collaborative data use include timely access to data or other evidence of student learning (Kerr et al., 2006; Lachat & Smith, 2005; Lasley, 2009; Marsh, Pane, & Hamilton, 2006; Supovitz & Klein, 2003; Wayman & Cho, 2007; Young, 2006), tools or guides for collaborative activities (Cosner, 2011b; Little & Curry, 2009; Nelson, 2008) and additional professional development (Cosner, 2011b; Datnow et al., 2007; Fuchs et al., 1999; Kerr et al., 2006; Saunders et al., 2009; Supovitz, 2002; Wayman & Cho, 2007).

Organizational culture plays a significant role in both collaboration and data use. Research on professional community emphasizes the need for trust, a focus on student learning, shared values, deprivatized practice, and reflective dialog to establish productive collaboration (Bryk & Schneider, 2002; Hord, 1997; Kruse, Louis, & Bryk, 1995; McLaughlin & Talbert, 2001). Research on data use similarly implicates the culture of schools as a factor in teachers' data use. This body of work suggests that a focus on student learning (Saunders et al., 2009; Supovitz & Morrison, 2011; Vescio et al., 2008), norms and expectations for inquiry (Copland, Knapp, & Swinnerton, 2007; Datnow et al., 2007; Honig & Venkateswaran, 2012; Ikemoto & Marsh, 2007; Ingram et al., 2004; Lachat & Smith, 2005; Supovitz & Klein, 2003; Wayman & Stringfield, 2006), trust (Herman & Gribbons, 2001; Ingram et al., 2004) and shared leadership (Blanc et al., 2010; Copland, 2003) are all cultural elements that support productive use of data.

Both the allocation and coordination of resources and establishment of positive organizational cultures are in large part functions of district and school leadership. The literature has documented a number of leadership actions that constrain or support collaborative data use (Anderson, Leithwood, & Strauss, 2010; Blanc et al., 2010; Copland, 2003; Cosner, 2011a,b; Datnow et al., 2007; Firestone & Gonzalez, 2007; Halverson et al., 2007; Hamilton et al., 2009; Honig & Venkateswaran, 2012; Ikemoto & Marsh, 2007; Knapp, Copland, & Swinnerton, 2007; Supovitz & Klein, 2003; Wayman, 2005; Weinbaum, 2009; Young, 2006). However, implications for leadership extend beyond the indirect effects of the cultivation of supportive organizational conditions. To the extent that decisions impact who participates, when and how often, and what data are available, leaders significantly and directly influence the design and implementation of any initiative (Coburn & Turner, 2011; Sherer & Spillane, 2011). Furthermore, how reform is understood and communicated by leadership can impact how reform is implemented (Coburn, 2005; Cosner, 2011b; Hill, 2001; Spillane, Reiser, & Reimer, 2002).

#### **The present study**

According to the theory of action underlying the mandate for PLCs, collaborative data use is a key intermediary outcome in the

process of impacting teaching practice and student learning. The Delaware approach to collaborative data use is supported by a growing body of empirical evidence about the relationship between collaboration, data use, teacher learning and practice, and student learning. At the same time, a long history of implementation research demonstrates that mandates from higher levels of the system rarely produce the intended outcome, and that local contexts, including resources, beliefs, and leadership, influence how reform is enacted. In order to be successful, the DE DOE must rely on districts and schools to implement the mandate in ways that generates the linkages theorized in Fig. 1. The purpose of this research is to learn from the early implementation experiences of four elementary schools in two districts, with particular attention to whether and how schools' implementation fostered collaborative use of data. The following questions guide our analysis:

1. What is the context of implementation at the state, district, and school level?
2. How are schools implementing the mandate, in terms of time, supports collaborative activities, and data use?
3. What aspects of context and implementation are associated with the development of collaborative data use?

While the mandate makes explicit calls for structured time and an emphasis on data use, little specific guidance existed for how districts and schools should implement the reform. Research cited earlier supports the hypothesis that the resources, culture, and leadership of schools influence collaborative data use. We anticipate variability in these aspects of implementation across schools, leading to variability in teachers' use of data during PLC time.

#### **Methods**

Data for this analysis were drawn from a broader study of the role of data in school improvement efforts. During early data collection, district and school interviews indicated that PLCs were the primary vehicle for generating teachers' use of data. As a result, we refocused our data collection strategy to incorporate PLC implementation and practices. We focus on the analysis of those data in this paper.

The study employed a sequential mixed methods approach in which interviews, observations, and document analysis informed survey design. Data were collected during the 2010–2011 school year from four elementary schools in two Delaware districts. Districts were selected based on comparable size and diversity of population. Schools were selected with the advice of the superintendents, who identified one school where data use was considered strength and another as an area of improvement. We recognize the fallibility of this method of identifying a purposive sample of schools, but lacking more objective indicators of data use, we must rely on those administrators best positioned to assess schools' practices. Table 1 provides demographic and achievement profiles for the four sites.

#### *Data collection*

Qualitative data took the form of semi-structured interviews with nine district administrators in two districts, based on title and superintendent's recommendation of those responsible for curriculum, instruction, accountability, and data. District interviews gathered information on district's expectations for PLCs, school improvement planning, and access to and expected use of both local and state data. We interviewed ten school leaders across the four schools, which included the principal, school leadership

**Table 1**  
 Demographic and achievement profiles of district and school site, 2010–2011.<sup>a</sup>

District	A		B	
	A1	A2	B1	B2
Elementary school				
Student enrollment (approximate)	530	475	700	700
White	18%	42%	57%	26%
Black	50%	17%	20%	10%
Hispanic	30%	37%	16%	58%
Low-SES	88%	68%	62%	81%
ELL	20%	26%	8%	42%
Special education	12%	9%	11%	14%
Meeting/exceeding math standard Spring 2011	85%	66%	85%	74%
Meeting/exceeding reading standard Spring 2011	85%	69%	78%	68%

<sup>a</sup> On this point, we observed between-PLC variability in data use practices that are not explored in the scope of this paper; we acknowledge this is an important finding and warrants further research.

teams, and teacher leaders. School interviews covered much of the same ground as the district interviews, but focused at the individual building level. We also conducted 21 school visits, including a mix of school leadership meetings, professional development, and PLCs. Lastly, we asked principals and teacher leaders, including documents related to school improvement planning, PLC administration, and data use. Appendix A provides information documenting data collection by school and district. Schools varied in what they sent, ranging from complete minutes of meetings and reports on grade level data to school action plans. Publicly available documents from the DE DoE were also used to identify state and district approaches to PLCs, evidenced through district RTTT plans and state LEA Support Program documents.

The research team reviewed the qualitative data to inform the survey, administered in May-June of 2011. The survey included questions about specific PLC practices based on the state mandate as well as interviews and observations; for example, one administrator expected teachers to use PLC time for pacing, leading us to ask about the degree to which pacing was a focus of PLC work. Questions were closed-ended, consisting of multiple choice categorical responses and Likert-type scales. Questions about frequency of behaviors included five response options, ranging from every meeting to never. Agreement scales included six response options, ranging from strongly disagree to strongly agree.

The portion of the survey which dealt exclusively with PLC practices included questions that offer insight into first two elements of the theory of action underlying the mandate: compliance with the mandates and reported PLC practices. Specifically the instrument collected responses about: (a) frequency and length of meetings, (b) attendance from instructional specialists or administrators, (c) content of meetings as they relate to curriculum and instruction, and (d) expectations, supports, and practices related to data use. Data use questions focused specifically on assessment data (e.g., formative assessments, curriculum-based assessments, student work, grades, and state test data) and demographic data. While other forms of data are available and relevant to instructional decision-making, the implementation context for PLCs emphasizes assessment data use and accountability, evident in both district and state investments in assessment systems. These investments produced increased expectations for use of particular assessment data. We add a focus on demographic data because of its centrality in calculating Adequate Yearly Progress, which may influence its use in instructional decision-making.

In addition to surveying teachers about practices, we used the survey to generate school-wide measures of culture to

contextualize our results. The survey included variations on existing scales from previous research, including shared norms, reflective dialog, deprivatized practice, collective responsibility, and shared leadership (Kruse & Seashore Louis, 1993; Kruse et al., 1994), teacher trust (Hoy & Tschannen-Moran, 2003), and principal leadership (Wayman, J. C., Cho, V., & Shaw, S. M., 2009). Appendix A presents more information about the items and reliability.

The survey was administered to all instructional staff in each school, with greater than 80% response rates from three schools and a 60% response rate in the fourth. In the three schools with the highest response rate, the survey was administered on paper during a faculty meeting at the close of the school year. The survey was administered online to the fourth school, which explains the difference in response rate. However, responses in this school were distributed across all grade levels (and therefore PLCs) which means that data are available to characterize all PLCs in this school. In total, 42 members of the staff responded from School A1, 24 from A2, 39 from B1, and 35 from B2.

### Analysis

In order to answer our first research question, we utilized qualitative and survey results to contextualize implementation of the mandate. Qualitative data were coded using an a priori framework based on the purposes of the larger study; this framework used broad themes to create tree nodes in NVivo9 related to PLCs, school and district context, data, state policy and accountability, and supports/expectations for data use. The initial set of codes was completed by the research team, with two rounds of reliability tests to ensure at least 90% agreement. NVivo9 was then utilized to create a matrix in which the codes were disaggregated by school site (columns) and data source (e.g. central office, school leaders, documents) to enable analysis of the data within and across cases. Survey data was analyzed descriptively to describe the cultural context of the schools using the scales described above, using ANOVA and Tukey's post hoc comparisons to identify statistically significant differences between schools.

In order to answer our second research question regarding PLC practices, including collaborative data use, we analyzed survey data to compare responses between schools and districts, using qualitative data as additional verification of findings. For survey items producing nominal and ordinal data, we utilized cross-tabulation and chi-square tests for statistical significance. For items producing data that can be interpreted as numerical data (e.g. agreement scales), we compare means and utilize ANOVA and Tukey's post hoc comparisons to identify statistically significant differences between schools. It is important to acknowledge here the nested nature of the survey data. Conceptually, teachers are nested within PLCs, which are nested within schools. However, given the small sample size, HLM analyses were not conducted. While there are many important questions that could be considered in an analysis of PLC implementation both within and across schools, our analysis revealed few statistically significant differences between PLCs within schools and many significant differences between schools. We therefore present school-based differences in the implementation of PLCs, noting statistically significant within school variability where relevant.

To examine the final research question, we utilize methods are consistent with a cross-case synthesis approach in which each school and district are analyzed separately for relevant themes and results are compared across cases. The qualitative matrix and disaggregated survey results by school were integrated to create a larger matrix organized by research question. This facilitated the development of a profile of each school which is used to compare and contrast both implementation of the PLC mandate (the

designed routine) and teachers' collaborative data use (the intermediary outcome).

## Results

### *Context of implementation*

Our first research question sought to explore the context of implementation. In 2010–2011, all Delaware schools implemented the mandated "PLC time" as proposed under the RTTT competition. This implementation occurred within the context of policies and resources at both the state and district levels that already supported teachers' use of data. At the state level, Delaware had recently developed and implemented a new state assessment. Unlike prior versions, the new assessment was administered three times during the year (fall, winter, spring) rather than once annually, which provided schools with baseline and progress-monitoring information during the course of the year. Though implemented for the first time in 2010, schools were anticipating that this assessment data would be valuable during the course of the year and permit mid-course corrections at various levels of the system. To support such use, the Department of Education had proposed Data Coaches to be deployed to PLCs, though these supports were not implemented in our schools during the 2010–2011 school year.

At the district level, both districts had contracted with a statewide data service center to provide data files and reports summarizing student achievement on local assessments, state achievement data is imported into this same database, freeing teachers, schools, and districts from compiling student information. Teachers are able to log on to a central system and download comprehensive reports on their own students across a broad set of measures. Relatedly, both districts had invested in the development of what they each called "common assessments", which were accessible through the data system. These were standards-based interim assessments in the core subject areas – reading/ELA, mathematics, social studies, and science – developed and modified by teacher committees in the district.

While these conditions were common to all schools in our sample, our analyses also demonstrated a great deal of variability between both districts and schools, particularly as they relate to experience with PLCs, expectations for the reform, and school culture. At the time of the state mandate, not all schools were new to the concept, as indicated in school and district interviews. School A1 and both Schools B1 and B2 had prior experience with PLCs; in the case of A1, the principal had introduced PLCs during his first year in the building, two years' prior. In District B, PLCs were introduced by a previous superintendent in 2004, and grade-level PLCs were common across all elementary buildings. In spite of these varied experiences, interviews reveal common emphasis in districts and schools that PLCs were a vehicle of for improving instruction. At the district level, both emphasized the importance of teachers working together in making instructional improvements and adopted the DuFours' model to guide implementation in their district.

Nevertheless, districts articulated the role of PLCs in their larger improvement efforts differently. District A considered PLCs a "cornerstone" of improvement to integrate efforts to improve instructional strategies, meet the academic and non-academic needs of diverse students, develop and align curriculum and assessment, and provide professional development. District A also set specific goals for compliance with the mandate, including scheduling 90 min of collaborative time.

District A's understanding is evident, to varying degrees, in school leaders' understanding of and expectations for PLCs. The principal at A1, a school with more PLC experience, emphasized team and leadership development through collaboration, and suggested that many teaching-related activities should be done in

this collaborative environment, including discussing lesson plans, sharing activities, discussing how students were doing, and ultimately delving into specific topics based on an agenda and goals they would develop together. At A2, the principal had longer term expectations for similar types of PLC activities, referring to critical analysis of assessment, reflection, and goal setting, but recognized the first year was a learning process.

District B has a much longer history of implementing PLCs, and considered them to be a "prominent feature of [the district] culture." As a result, District B responded to the mandate to expand the focus of PLCs to include data use to improve instruction. District administrators expected teachers to use data in their PLCs, and, as one put it, "We hope their time is divided between... using the [common] assessments and... their best interventions based on the data". Throughout its RTTT plan, District B emphasizes the professional development for data use afforded by PLCs with one goal specifically ensuring implementation of 90 min of collaborative time for all teachers. In this sense, District B emphasized compliance as well as instructional improvement.

In B1, school leaders emphasize PLCs as a vehicle for using data to inform instruction. Principal B1 states, "the focus is to be on instruction and guiding the instruction through data decisions", and refers to grouping and instructional decisions with the data "right there in front of them". Principal B2 did not explicitly discuss data use expectations for PLCs, but rather stated "the expectation is first of all you talk about lessons... we like for the teachers to plan together." Additionally, the principal emphasized the role of PLCs in empowering teachers to make and participate in decisions, as well as the collaborative purposes of PLCs.

While all recognized the potential for PLCs to improve instruction, district offices and schools adopted differing perspectives on what this meant for teacher collaboration during PLC time. These variations are key parts of the context for implementation. In addition, the culture of the organization is a potentially significant factor in the development of collaborative data use. To contextualize the reform, we analyzed several dimensions reported in Table 2. ANOVA results indicate statistically significant differences for all dimensions of culture, and using Tukey's post hoc test, we found that A1 consistently differed significantly from others, with additional differences between B1 and the other schools on some dimensions (trust, shared leadership, and principal leadership). Thus A1 consistently demonstrates the strongest culture in dimensions likely to support collaborative data use, while A2 consistently demonstrates the weakest in the sample. B1 and B2 represent a middle range on these cultural elements.

Our data indicate the context-including understanding, expectations, and culture-varied substantially across schools, and this variability is further manifested in school and district implementation of the mandate.

### *Implementation of PLCs*

Our second research question focuses on school implementation of the mandate. We consider these in terms of four

**Table 2**

Mean school ratings on different cultural dimensions (see Appendix A for construction of scales).

Scale	A1	A2	B1	B2
Shared norms	16.28	13.55	14.92	14.55
Teacher trust	20.94	15.81	19.37	19.06
Reflective dialog	10.78	9.21	10.08	9.97
Deprivatized practice	20.03	14.06	16.97	14.21
Collective responsibility	15.78	12.11	13.23	13.62
Shared leadership	19.55	12.85	17.44	15.40
Principal leadership	21.03	17.61	19.68	18.84

dimensions: time allocated and used for PLCs, leadership and facilitation supports, PLC practices, and the role of data in PLC practices.

#### Time

Both observational and survey data revealed different approaches to structuring the mandated collaborative planning time. Both District A schools consistently met the mandate by scheduling 45 min during the school day and 45 min before or after school on a regular basis; this practice was explicitly prescribed in the district's RTTT plan. They were able to do this through creative scheduling with non-core teachers or other personnel without detracting from instructional time. In both schools, all instructional personnel participated. District A schools clearly met state expectations for scheduling while also protecting teachers' time and instructional time.

Compliance was an issue in both District B schools. District documents specifically delegate the decision to schools, but set an explicit goal to address scheduling difficulties. Schools B1 and B2 did not establish a consistent schedule, provide time during the school day, or meet the required minutes every week. In B1, some indicated PLCs met bi-weekly (22%), weekly (54%), or less (24%) and for varied lengths of time that did not always meet the mandate. In B2, PLCs met one time per week, but for between 30 and 90 min depending on the team, with only 10% of teachers reporting 90 min. Both schools' PLCs were scheduled for the end of the school day, which leaders explained was a function of finding adequate classroom coverage during the day.

#### Support

Our data illustrate significant variability in the supports provided by district or building administrators to PLCs. According to interviews, District A supports included professional development for principals and teachers, including sending all administrators to the DuFours' national conference, arranging technical assistance sessions with the DuFours for teacher leaders and instructional coaches, and making PLC implementation a permanent agenda item at district-wide principals' meetings.

Within District A, the schools differed in the supports integrated into grade level PLCs. School A1 PLCs received frequent and consistent attendance from instructional specialists as well as an administrator. In the survey, 92% of teachers reported a specialist coming most or every meeting, and 60% reported an administrator comes to most or every meeting. Interviews and observations revealed that in this school, the principal assigned instructional specialists – reading coaches and teachers, math interventionists, ELL teachers, and district instructional coaches – to all teams. The specialists varied, depending on the needs of the PLC and their students. They served many purposes, including helping to interpret student data, suggesting instructional materials or strategies, modeling or co-teaching, and working with groups of students when necessary. They also kept their respective PLCs focused on the task at hand. Furthermore, Principal A1 consistently attended PLC meetings as an active member rather than observer and reviewed agendas and minutes from each PLC in order to target supports. As he noted:

You have to be actively involved in the process and participate along with the team. I consider my role primarily to support the collaborative process of these teachers to create that kind of culture or team work; I consider that to be my most important role. And then monitoring what's going on, walkthroughs and visiting classrooms. . .

In School A2, the presence of specialists was more sporadic. In the survey, 27.2% reported a specialist coming to every or most meetings while 27.3% reported they rarely attended. For

administrator attendance, the majority indicate the principal attended some meetings, but 40.9% reported rare attendance. Interviews and observations in this school revealed specialists and building principal met regularly as their own PLC, discussed the progress of individual PLCs, and provided supports, but more often to individual teachers or groups of students, rather than as a resource to the entire PLC. The principal collected and reviewed minutes from the PLCs to better support the teams.

In District B, there were less explicit supports for PLC implementation. As the Superintendent stated, "we don't really think of PLCs as an initiative for us anymore because it's just part of what we do." District documents refer to extensive district-wide training during the 2004 adoption of the DuFours' model. The district offers a Leadership Institute, part of which focuses on how to strengthen PLCs in schools.

Based on survey data, B1 and B2 teachers reported little consistent involvement from either instructional specialists or administrators. In both B1 and B2, only 10% of teachers reported a specialist coming to every or most meetings, while more than half in each school indicate these resources rarely or never attend meetings. In both schools, administrators attend more often with about half attending some meetings with the rest reporting less frequent attendance. According to interviews, administrators' and specialists' role in PLCs varied, with some considering their presence to be a resource for teachers to use if needed, and if not, as passive observers. In both schools, principals had a very hands-off approach to PLCs. Principal B1 did not want to be viewed as "the PLC police".

The four schools varied in the expectations for data use set by the building administrators, according to survey results. Schools A1, A2, and B1 all reported agreement about expectations for using data (means >5 on a 6 point scale), while teachers were less likely to agree in B2 (mean = 4.5). In spite of general agreement about expectations, these manifested themselves differently across schools and districts in school observations. In A1, teachers were expected to examine data on district quarterly benchmark or formative tests and to set short-term goals for student performance between these tests. Smartboards were used to post both goals and student results by individual teacher in faculty meetings; these meetings also were used to celebrate successes. In A2, PLCs were allowed to decide how to set goals; data were shared across individual team members but not across different grades. In B1 and B2, discussions about data focused more on state-mandated tests rather than district benchmark or formative tests. B1 and B2 PLCs set annual goals, but there was no expectation to set short-term goals for student performance on these tests and no sharing across grade levels or the overall school. In addition, neither B1 nor B2 celebrated successes during the school year.

Differences are also reflected in the support available for using data, as illustrated in interviews. Drawing on survey data, teachers in A1 were most likely to agree that there are clear guidelines for using data and that an administrator helps guide data use (means 5.0 and 4.7 respectively, 6 point scale). The other three schools reported similar agreement about guidelines (mean = 4.1 for all three), but varied on whether an administrator/specialist was available to guide data use: A2 had a mean of 3.5, B1 had a mean of 4.0, and B2 had a mean of 3.8.

#### PLC practices

Not surprisingly, variability in understandings about what PLCs should look like, coupled with different approaches to and supports for implementation, manifested itself in diverse practices across schools. We present findings in two ways: first, we present results about the type of collaborative work teachers engaged in during their PLC meetings, and second, we examine teachers' direct reports of data use in PLCs.

**Table 3**  
PLC collaborative work by school, as measured by frequency of practice (1 = every meeting, 5 = never).

	A1	A2	B1	B2
	Mean	Mean	Mean	Mean
<i>Analysis</i> <sup>*</sup>	1.93	2.65	2.49	2.71
Discuss how a lesson went <sup>*</sup>	2.15	2.67	2.59	3.19
Discuss school wide goals <sup>*</sup>	2.3	3.10	2.73	3.31
Discuss student behavior <sup>*</sup>	1.7	2.83	2.77	2.14
Discuss students are getting it <sup>*</sup>	1.74	2.43	2.23	2.64
Discuss team/grade level goals	2	2.37	2.55	2.47
Discuss whether particular strategies are working <sup>*</sup>	1.59	2.30	2.32	2.42
Examine student data <sup>*</sup>	2.03	2.87	2.27	2.78
<i>Action</i>	2.09	2.32	2.39	2.47
Discuss pacing of curriculum/instruction <sup>*</sup>	2.15	1.83	2.55	1.72
Address individual student issues <sup>*</sup>	1.75	3.00	2.5	2.47
Map the curriculum to an assessment <sup>*</sup>	2.69	3.03	2.41	3.29
Plan particular lessons	2.46	2.67	2.55	3.03
Review curricular materials	2.18	1.80	2.45	2.11
Set curricular or instructional priorities	2.18	2.47	2.32	2.60
Share instructional strategies <sup>*</sup>	1.64	1.97	2.18	2.43
Share materials or resources <sup>*</sup>	1.63	1.77	2.19	2.11

<sup>\*</sup>ANOVA results indicate differences in school means are statistically significant at the <.05 level.

*PLC activities*

Table 3 presents survey results for the type of collaborative activities teachers engaged in during PLCs. While not all categories represent direct measures of teachers' use of data, this information helps establish the type of collaborative work in which data use practices were enacted. We included a broad array of practices; including those that focus explicitly on student data (i.e., examine student data) and other that implicitly include data use (e.g., discuss how a lesson went, discuss whether students are getting it). Drawing on research by Marsh et al. (2006) and Cosner (2011a), we separate practices into activities that involve the generation of knowledge about student learning (analysis-oriented tasks) and activities that entail applying that knowledge to instructional decisions (action-oriented tasks). This distinction helps us to understand data use as situated in the process of teacher learning (through analysis) and instructional improvement (through action taken with data). In Table 3, mean indicates the numerical average of responses ranging from 1 (every meeting) to 5 (never). Mode indicates the most frequent response and the percent of teachers indicating that response. Rank indicates the relative prevalence of that practice within each school, based on mean.

An examination of reports of specific practices show common patterns in what teachers engaged in during PLCs. However, more important than teasing out complex patterns in the specific practices reported is the relationship between work that is analysis- or action-oriented. The theory of action underlying the mandate requires that teachers engage in both analysis- and action-oriented tasks to be successful in impacting teacher practice and student learning. Our data indicate that the former did not occur at the same frequency as the latter, which raises questions about whether instructional actions are grounded in the analysis of student data. A1 statistically significantly engaged in analysis-oriented tasks more often than any of the other three schools, and A1 is the only school where analysis appears prioritized, as these practices occur more frequently than action-oriented tasks. Further, Tukey's post hoc comparisons indicates A1 is statistically different than other schools across most practices. The other three schools more often engage in and prioritize action-oriented tasks, though to varying degrees. B1 shows only a small difference between action and analysis-oriented tasks (difference in means of

.10), while A2 and B2 show more substantial differences in emphasis (difference in means of .3). While the size of this difference is difficult to interpret, qualitative data from interviews and observations supported this finding. Administrator and teacher interviews reinforce that connecting data use to instruction remains an area for continuous improvement. As one administrator indicates:

I think that teachers need way more practice in getting down to the item level to really look at specific items and being able to analyze their class performance and what it is that data says about how something was taught or how something was not learnt or learnt. I think that still is the big issue that we are trying to get by, it's okay, it's not—I have tested now I go on. So I tested now what do I do with what I learnt from what I tested. That's the piece... I think professional learning communities is the valuable piece and what we are going to do now with these kids...

In comparison, School A1 demonstrated a variety of ways in which data were integrated into teachers' work in PLCs. A district administrator explains PLCs in this school:

I mean, so they are talking with another teacher, I mean, really being able to look at the assessment data, talk about the strategies of how they are doing that checking for understanding... you can see how natural it is, that they are taking that next step using our data, being able to provide those interventions for kids in the core, and using the strengths of the teachers and how they approach to try to bring all kids up. So I mean, you can see not just how well the PLC is functioning, but you see it play out. And I think that is to me the ultimate level of how you used your data.

*Data use in PLCs*

Survey patterns in the type of collaborative work teachers engaged in during PLCs (Table 3) are similar to patterns found in teachers reports of how they incorporate data into that work (Table 4). Here, we focus on how data is used in several analysis-oriented tasks (evaluating student learning, monitoring progress toward goals, evaluating what strategies are working, evaluating content or pacing, determining whether students are "getting it") and action-oriented tasks (informing grade-level or subject area decisions, setting PLC goals or curricular or instructional priorities, and determining individual interventions). Teachers in each school

**Table 4**  
Teachers' reports of data use in PLC work, as measured by frequency of use (1 = every meeting, 5 = never).

	A1	A2	B1	B2
	Mean	Mean	Mean	Mean
<i>Analysis</i>	2.09	2.22	2.59	2.40
Determine whether students are getting it during or after a particular lesson <sup>*</sup>	1.97	2.15	2.64	2.36
Evaluate curriculum content or pacing	2.30	2.45	2.42	2.11
Evaluate student learning	2.05	2.15	2.53	2.43
Evaluate what instructional strategies are working	1.97	2.10	2.50	2.39
monitor progress toward PLC goals <sup>*</sup>	2.17	2.25	2.86	2.70
<i>Action</i>	2.23	2.36	2.69	2.52
Discuss interventions for individual students <sup>*</sup>	2.00	2.25	2.69	2.93
Inform team decisions about about curriculum or instruction <sup>*</sup>	2.34	2.70	2.97	2.36
Set curricular or instructional priorities	2.22	2.11	2.53	2.29
Set PLC goals	2.37	2.40	2.58	2.50

<sup>\*</sup> ANOVA results indicate differences in school means are statistically significant at the <.05 level.

**Table 5**  
School profiles based on PLC implementation.

	A1	A2	B1	B2
<i>Context of implementation</i>				
District history/expectations	No experience, explicit statements about vision for and role of PLCs, specific commitment to training, support		Several years' experience, less explicit about vision for PLCs as reform mechanism, no specific commitment to training, support	
School history/expectations	Experienced, PLCs as a way to build teacher capacity	No experience, no clear statement about PLCs	Experienced, PLCs as a way to build teacher capacity	Experienced, PLCs as a way to empower teachers
Culture for PLCs	Strongest culture for professional community	Weakest culture for professional community	Mixed culture for professional community	Mixed culture for professional community
<i>Implementation of PLC mandate</i>				
Time	Regular, consistent schedule	Regular, consistent schedule	Inconsistent schedule	Regular frequency, varied length
Supports: data use	Expectations and support	Expectations, fewer supports	Expectations, some supports	Some expectations, some supports
Supports: leadership/facilitation	Frequent and consistent attendance from specialist as well as an administrator	Some attendance by specialists less often for administrators	Little consistent involvement from specialist as well as administrators	Little consistent involvement from specialist as well as administrators
Supports: monitoring	Active review of agendas and minutes	Collected minutes for review	No active monitoring	No active monitoring
<i>Teachers' use of data in PLCs</i>				
Collaborative practices	Engaged in broadest range of practices in at least most meetings, on average; prioritized analysis-oriented tasks	Fewer prioritized practices occurring in "some" meetings; prioritization of action over analysis-oriented activities	Broad range with many practices at most but not every meeting; similar prioritization of analysis and action-oriented tasks	Less consistent set of practices, with majority used sometimes; prioritization of action over analysis-oriented activities
Data use: sharing data	Strong on vertical and horizontal sharing	Sharing horizontally, but not vertically	Weak on sharing in general	Sharing horizontally, not vertically
Data use: using data	Most frequent applications across practices, uses most forms of data; emphasis on analytical tasks	Frequent applications for most practices, fewer forms of data; emphasis on analytical tasks	Least frequent for most practices, fewer forms of data; emphasis on analytical tasks	Mixed frequency for some practices, fewer forms of data; emphasis on analytical tasks

reported using data for all of these practices – both analysis- and action-oriented, and in all schools, data was used more frequently in analysis-oriented tasks than action-oriented ones, but to notably varying degrees (Table 4). Most practices were statistically significantly different between schools, though Tukey's post hoc comparison indicates A1 was consistently statistically significantly different from at least one other school in our sample. In fact, data in Table 4 indicates teachers in A1 consistently integrated data into all practices in at least most meetings, with some used in every meeting, making it the school in which data was incorporated into PLCs most often. In all schools, teachers engaged in data use more often in analysis-oriented tasks than action-oriented though for each school the prioritized tasks within each category varied.

With respect to the types of data used, survey data showed that PLCs in all schools examined multiple types of data related to student learning. This is not surprising given the common data system in which both districts participate. However, in A1 a majority of teachers reported regularly incorporating a wide variety of data into PLC conversations, whereas in other schools PLCs, fewer teachers reported using each type of data. Overall, formative and interim tests were most frequently used, and both grades and state tests were used least. Notable differences were found in use of student work and demographic data. Teachers in A1 and A2 both reported using student work in their PLC practices more frequently than in B1 and B2, where student work was among the least frequently used data. A vast majority of teachers in B2 reported using demographic data in their PLCs, though we have no further information on how this might have been incorporated.

In addition to specific tasks in which data was used during PLC time, we also surveyed teachers specifically about whether and how data was shared, as teachers do not have personal access to data from other classrooms or grades. Teachers in A1 were most

likely to share their own classroom data within PLCs as well as between PLCs, and had clear norms about sharing data as evident in schoolwide expectations discussed under supports above. Teachers in A1 most often shared their data with others and discussed other teachers' data, and compared data across classrooms and grades between some and most meetings. There were less clear school-wide norms about sharing data in A2, though teachers were more likely than those in District B to share data, averaging between most and some meetings for sharing their own data, discussing other teachers' data, and comparing across classrooms. They were less likely to compare across grades.<sup>4</sup> Schools B1 and B2 have unclear norms about sharing data, and there are some between school differences. Teachers in B2 reported sharing data with others, looking at other teachers' data and comparing data across classrooms, though less often than A1 or A2. Data was rarely shared across grade levels. Teachers in B1 were least likely to engage in sharing data, averaging "some" meetings for all forms of sharing, except comparing data across grades, which was significantly less often.

*The relationship between context, implementation, and collaborative data use*

The third research question focuses on the intersection of context, implementation, and teachers' collaborative use of data and explores sources of variability. That is, what characteristics of context and implementation seem to explain differences between schools and between districts? In Table 5, we present brief profiles of each school and district which summarize the results presented

<sup>4</sup> Data accessed through school profiles on the Department of Education website: <http://profiles.doe.k12.de.us/SchoolProfiles/State/Default.aspx>.

earlier. These profiles offer a basis for considering how the context and implementation of PLCs supports or fails to support teachers' development of data use practices.

These profiles suggest that the cultivation of data use in PLCs occurs along a continuum. More specifically, how teachers engage with and use data in PLCs is associated with other aspects of professional community, including supports and expectations, leadership, and school culture. At one end, School A1 exceeded minimum implementation in terms of time and district/school support, and shows the strongest evidence of teacher capacity to use data to improve teaching and learning. Ultimately the highest performing, A1 is in many ways the model of what the state mandate intended to achieve. In contrast, PLCs in other schools struggle to produce the same results. What, then, explains the difference? Our analysis identifies a number of characteristics distinguishing A1 from the other schools: consistent district and school leadership vision and support for PLCs as a vehicle for collaborative data use, a strong culture of professional community, leader-established norms and expectations, monitoring of PLCs, and allocation of instructional resources to PLCs.

The two districts in our sample had very different experiences and approaches, which may explain differences in implementation issues such as compliance with time, expectations and supports, and the types of data used. We found that district and school understanding of and expectations for the mandate, and supports provided by either the district and/or school, affected implementation. Districts and schools may also lose the potential power of the state mandate when they do not marshal additional attention and resources to signal its priority. For example, District B schools have had long-term experience with PLCs and relied heavily on this past experience, rather than taking advantage of the state mandate to reinforce its vision and expectations for PLCs.

Our data also suggest that district vision and support are not sufficient. School leaders mediated the impact of the district on reform implementation when they do not echo and reinforce these same district messages. Explicit statements of vision and expectations from district reinforced by school leadership in A1 produced the strongest PLC implementation. In contrast, A2 enjoys the same district vision and supports as A1 yet the principal did not articulate a clear vision for PLCs. Similarly, cultural differences across schools contextualize school implementation. The frequency and variety of collaborative discussions were greater in the one school that deprivatized data, formally set student achievement goals, and reported on their attainment throughout the school year. The other three schools had less clear norms for sharing data or setting goals schoolwide and school culture scales indicated lower levels of professional community.

School leaders in our sample also exerted *direct* influence on implementation through schedules set for collaborative meeting time, their attendance and monitoring of PLCs, and the provision of additional resources. Principal A1 established a consistent schedule and release time, attended meetings as an instructional leader, and actively monitored collaborative work. In A2, PLCs were compliant with time requirements, but teachers reported less administrator instructional support and monitoring occurred less frequently. In spite of past experience and principals' articulation of a vision for PLCs, B1 and B2 are less clearly compliant with the time requirement, and school administrators at both buildings generally did not attend PLCs or exert much accountability.

Finally, our analysis indicates significant differences in access to instructional support. Principals in our sample acknowledged that teachers needed support to make instructional decisions based on data. Principal A1 assigned instructional specialists to each PLCs who regularly attended weekly meetings and reinforced the vision of the state, district and school for PLCs. The provision of these personnel helped strengthen the link between analysis- and

action-oriented tasks. Principals in the other three schools did not provide such consistent instructional support, and our data illustrate that connecting data to instructional decision-making was weaker in those schools.

## Discussion

The research presented here examines the implementation of a mandate for PLCs as a vehicle for improving teaching and learning through teachers' collaborative data use. Evidence from our limited sample suggests that the state mandate, by itself, produced opportunities for collaborative teacher use of data. In response to the mandate, districts and schools set aside time for collaborative teacher work analyzing data and planning instruction and provided access to student data through a statewide data service center. Further, evidence also indicates that teachers actually engaged in data use during that time, though the nature of use varied significantly between schools. From this narrow vantage point, the mandate was successful. However, building from the underlying theory of action, our findings suggest that mere compliance is not sufficient for developing the type of collaborative practices likely to impact teacher knowledge or practices or, ultimately, student learning. Rather, as noted in the mandate's theory of action, the development of the four components to effective PLCs depends on several aspects of the organizational context. Our findings corroborate this theory of action and re-emphasizes the importance of conditions previous research has demonstrated as essential for data use, including the provision of structured time, access to data systems, a culture of professional community, and instructional leadership exerted by both district and school leaders. Although our study confirmed the importance of these conditions, there are nuances to our findings that constitute new contributions to the field. We highlight these in the following discussion.

### *Mandates, routines, and data use*

Evidence presented here regarding the importance of regular, consistent meeting time and access to data is consistent with literature that finds designed routines – here, structured collaborative time – can be levers for changing practice in schools (Feldman & Pentland, 2003; Sherer & Spillane, 2011). Though the mandate can be narrowly considered successful across schools, the ways in which districts and schools understood, communicated, and implemented the mandate appear to mediate the ways in which “PLC time” built the capacity of teachers to engage in collaborative data use. This suggests that the potential for designed routines to leverage change may depend, at least in part, on where the routine originates. In the work of Sherer and Spillane (2011), the routine originated with the principal and was implemented by teachers. In contrast our research documents a routine established by the state, which moved down through districts, to school leaders, and to teachers. This created opportunities at multiple levels of the system for the routine to be (mis)understood, (mis)communicated, and adapted by local leadership. While research has well documented the interpretation and adaptation of policy at multiple levels of the system, as organizational routines become an increasingly popular strategy for leveraging change in practice, research bridging these two lines of inquiry could provide further guidance for educators implementing such reforms.

### *Connecting data to instructional decisions*

Findings presented here also contribute to research on the process of data use (Coburn & Turner, 2011). Specifically, results provide some empirical support for the conceptualization of data

use as consisting of both action- and analysis-oriented activities, whereas earlier data use research often refers to the practice as a single activity (Coburn & Turner, 2011; Cosner, 2011b; Honig & Coburn, 2008). This distinction may be a useful way to characterize variability in practice within and across schools in future research. Relatedly, both qualitative and quantitative analyses suggest that teachers need support to connect what they see in the data to decisions about curriculum and instruction. The role of instructional specialists in teachers' collaborative data use – as well as principals' allocation of those resources as a form of instructional leadership – seems to be one mechanism in helping teachers make those connections. This finding is consistent with research that identifies pedagogical content knowledge and/or expert facilitation as important productive collaboration (Cosner, 2011b; Little & Curry, 2009; Parr & Timperley, 2008; Timperley, 2009).

#### *Role of district and school leadership*

Additionally, our research emphasizes the role of leadership at multiple levels of the system. Findings confirm the importance of a number of contextual factors often cited on data use or professional community, including school culture, access to data, structured time, and professional development. However, we attribute these conditions to the decisions and actions of leadership at both the school and district levels. The districts in our sample approached the mandate in distinct ways – one with more explicit commitment and ongoing support, and the other with a reliance on past experience – and these differences had implications for schools' enactment of the mandate. This supports previous research which has identified ways in which school implementation of policy – including data use reforms – are helped or hindered by the district office (see Honig & Venkateswaran, 2012; Wayman, Jimerson, & Cho, 2012 for a discussion). At the school level, our findings confirm the argument that leaders' decisions impact who participates, when and how often, and what data are available – therefore significantly and directly influencing the design of the organizational routine (Coburn & Turner, 2011; Sherer & Spillane, 2011). Aspects of implementation such as scheduling of time, monitoring of and tools to support activities, allocation of resources, and participation in PLCs varied across schools. These decisions reflect how the leader – in these schools, the principal – understands the mandate and implicitly communicates to teachers that interpretation.

Implications for district and school leadership point to an overall need to focus on system coherence. As previous research has pointed out, data use reforms benefit from a clear vision, common language, clear goals, and an aligned system of supports for leaders and teachers (Datnow et al., 2007; Halverson et al., 2007; Kerr et al., 2006; Supovitz & Klein, 2003; Wayman & Cho, 2007; Wohlstetter, Datnow, & Park, 2008; Young, 2006). Wayman et al. (2012) go further to argue while articulating goals, and policies are important, the work of building coherence also entails fostering meaningful conversations about teaching, learning, and data use. Because policies are subject to local interpretation – evidenced in this study – districts and schools can work to *develop* rather than simply communicate common understandings, which as Wayman and colleagues point out, supports how educators interpret, communicate about, and adapt their work toward organizational goals.

Relatedly, for leaders at both levels to effectively support implementation, they must possess sufficient knowledge of the reform, of data, and of instruction to make decisions and take actions that effectively support schools and teachers. This conclusion echoes calls for greater attention to professional development for leadership (Cosner, 2011b; Datnow et al., 2007; Supovitz & Klein, 2003; Wayman & Cho, 2007).

The current study has several limitations which influence the generalizability of its findings. First, the impact of the state mandate was examined in a very small sample of schools. In addition, one of our two districts had extensive prior experience with PLCs and thus began their response to the state mandate from a very different vantage point. We relied on teacher self-report as measures of collaborative work and data use which may not fully capture important aspects of practice, such as the content or quality of collaboration, discussions of data, or instructional decision-making. We echo others' calls for research that offers a more in-depth understanding of practice. Lastly, we focus only on the relationship between mandated PLCs and collaborative data use – an important but single piece of the theory of action connecting the mandate to student learning. Additional research will be needed to establish the path from policy to final outcome.

#### **Conclusion**

In summary, the Delaware mandate for PLCs resulted in the scheduling of structured time and teachers' collaborative use of data in all schools. However, the nature of collaborative work and the ways in which data were employed varied in ways that relate to key school and district differences. Findings illustrate the impact of how district and then school leaders mediated the state policy and communicated their expectations to teachers. Further, leaders' direct provision of supports differed significantly, in terms of structured time, instructional leadership from administrators, and deployment of specialists to meet PLC's.

In spite of the limitations of this study, our findings offer insight into the implementation of mandates as a mechanism for developing collaborative data use, both confirming and building upon previous research on data use. As initiatives designed to leverage data use through PLCs are increasingly popularized (Van Lare & Brazier, 2012), we extract from our findings lessons for those beginning down this path.

1. Mandates and policies for PLCs can create opportunities for change, but by themselves, are insufficient to create meaningful reform and can result in uneven or inconsistent implementation.
2. District leadership should focus on communicating a consistent vision and expectations for data use. This includes providing ongoing professional development for school and teacher leaders to strengthen their understanding of data use and how it can impact teacher instruction and actively monitoring school leaders' efforts in their individual schools. Central offices can also provide resources to all schools, such as centralized data use centers to facilitate access to and deprivatization of data and access to instructional specialists.
3. School leaders need to translate district vision into clear expectations to their schools. School leaders should focus on building a school culture that supports collective responsibility and deprivatized data *and* practice. Collective responsibility is unlikely to flourish without shared understandings of how all students are performing as well as how teachers are instructing. This entails access to a variety of data that is shared vertically and horizontally.
4. School leaders potentially can wield direct influence scheduling time for collaboration, deciding who participates in these collaborations, assigning instructional specialists to work with groups of teachers, and actively participating in and monitoring collaborative work in a supportive capacity. These decisions can create opportunities for modeling and reinforcing data use for analysis-oriented tasks and action-oriented tasks and communicate the importance of collaborative work in leveraging improved student learning.

**Appendix A**

Qualitative data collection.

District	A		B	
Interviews	Superintendent, Director of Curriculum & Instruction, Director of Assessment & Accountability		Superintendent, Assistant Superintendent, Director of School Improvement, Director & Supervisors (3) of Curriculum and Instruction	
Documents	Race to the Top plans			
School	A1	A2	B1	B2
Interviews	Principal, 2 teacher leaders	Principal, leadership team, teacher leader	Principal, leadership team	Principal, leadership team
Observations	4 PLC, 2 school wide PD sessions/meetings	4 PLC, 1 leadership team	4 PLC, 1 leadership team	4 PLC, 1 leadership team, 1 RTI team meeting
Documents	Sample PLC meeting notes and goal sheets, school improvement plans	PLC meeting logs, Data day activities, school improvement plans	Data day activities, leadership team agendas, school improvement plans	School improvement plan

**Appendix B**

Description of scale items.

Scale and Items (6 point agreement scale)	Responses	Chronbach's Alpha	Mean	SD
<b>Shared norms (Kruse &amp; Seashore Louis, 1993)</b> <ul style="list-style-type: none"> <li>• Most teachers in our school share a similar set of values, beliefs, and attitudes related to teaching and learning.</li> <li>• In our school we have well defined learning expectations for all students.</li> <li>• Our student assessment practices reflect our curriculum standards.</li> </ul>	130	0.742	15.04	2.17
<b>Teacher trust (Hoy &amp; Tschannen-Moran, 2003)</b> <ul style="list-style-type: none"> <li>• Teachers in this school typically look out for each other.</li> <li>• Teachers in this school trust each other.</li> <li>• Teachers in this school are open with each other.</li> <li>• Teachers in this school have faith in the integrity of their colleagues.</li> </ul>	125	0.959	19.14	3.80
<b>Reflective dialog (Kruse &amp; Seashore Louis, 1993)</b> <ul style="list-style-type: none"> <li>• Teachers have conversations with colleagues about the goals of this school.</li> <li>• Teachers have conversations with colleagues about what helps students learn best.</li> </ul>	127	0.884	10.14	1.48
<b>Deprivatized practice (Kruse &amp; Seashore Louis, 1993)</b> <ul style="list-style-type: none"> <li>• I have invited someone in to help teach my class(es).</li> <li>• I have had colleagues observe my classroom.</li> <li>• I have received meaningful feedback on my performance from colleagues.</li> <li>• I have visited other teachers' classrooms to observe instruction.</li> </ul>	120	0.841	16.83	4.74
<b>Collective responsibility (Kruse &amp; Seashore Louis, 1993)</b> <ul style="list-style-type: none"> <li>• Teachers feel responsible to help each other improve their instruction.</li> <li>• Teachers take responsibility for improving the school outside their own class.</li> <li>• Teachers help maintain discipline in the entire school, not just their classroom.</li> </ul>	124	0.84	13.91	2.90
<b>Shared leadership (Kruse &amp; Seashore Louis, 1993)</b> <ul style="list-style-type: none"> <li>• Teachers have a role in school-wide decision making.</li> <li>• Teachers have input into plans for professional development and growth.</li> <li>• School's principal(s) ensures wide participation in decisions about school improvement.</li> <li>• School teams (departments, grade levels, other groups) have direct influence on school decisions.</li> </ul>	129	0.934	16.91	4.45
<b>Principal leadership (Wayman, J. C., Cho, V., &amp; Shaw, S., 2009)</b> <ul style="list-style-type: none"> <li>• My principal or assistant principal(s) encourages data use as a tool to support effective teaching.</li> <li>• My principal or assistant principal(s) creates many opportunities for the faculty to use data.</li> <li>• My principal or assistant principal(s) has made sure the faculty has plenty of training for data use.</li> <li>• My principal or assistant principal(s) is a good example of an effective data user.</li> </ul>	126	0.834	19.60	3.08

**References**

Anderson, S., Leithwood, K., & Strauss, T. (2010). Leading data use in schools: Organizational conditions and practices at the school and district levels. *Leadership and Policy in Schools*, 9(3), 292–327.

Andrews, D., & Lewis, M. (2007). Transforming practice from within: The power of the professional learning community. In L. Stoll & K. S. Louis (Eds.), *Professional learning communities: Divergence, depth and dilemmas*. Maidenhead: Open University Press.

Blanc, S., Christman, J. B., Liu, R., Mitchell, C., Travers, E., & Bulkley, K. E. (2010). Learning to learn from data: Benchmarks and instructional communities. *Peabody Journal of Education*, 85(2), 205–225.

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

Christman, J., Neild, R., Bulkley, K., Blanc, S., Liu, R., Mitchell, C., et al. (2009). *Making the most of interim assessment data: Lessons from Philadelphia*. Philadelphia, PA: Research for Action.

Coburn, C. (2005). Shaping teacher sensemaking: School leaders and the enactment of reading policy. *Educational Policy*, 19(3), 476–509.

Coburn, C. E., & Turner, E. O. (2011). Research on data use: A framework and analysis. *Measurement: Interdisciplinary Research and Perspectives*, 9(4), 173–206.

Coburn, C. E., & Turner, E. O. (2012). The practice of data use: An introduction. *American Journal of Education*, 118(2), 99–111.

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- Copland, M. (2003). Leadership of inquiry: Building and sustaining capacity for school improvement. *Educational Evaluation and Policy Analysis*, 25(4), 375–395.
- Copland, M. A., Knapp, M. S., & Swinnerton, J. A. (2007). Understanding the promise and dynamics of data-informed leadership. In P. A. Moss (Ed.), *Evidence and decision making* (pp. 74–). Chicago, IL/Malden, MA: National Society for the Study of Education. Distributed by Blackwell Publishing.
- Cosner, S. (2011a). Supporting the initiation and early development of evidence-based grade-level collaboration in urban elementary schools: Key roles and strategies of principals and literacy coordinators. *Urban Education*, 46(4), 786–827.
- Cosner, S. (2011b). Teacher learning, instructional considerations, and principal communication: Lessons from a longitudinal study of collaborative data use by teachers. *Educational Management, Administration, and Leadership*, 39(5), 568–589.
- Datnow, A., Park, V., & Wohlstetter, P. (2007). *Achieving with data: How high-performing school systems use data to improve instruction for elementary students*. Los Angeles: University of Southern California. Center on Educational Governance.
- Delaware Department of Education. (2010). *Delaware education plan overview*. Dover: Author. <http://www.doe.k12.de.us/ritt/files/DEEducationPlanOverview.pdf>.
- DuFour, R., DuFour, R., & Eaker, R. (2008). *Revisiting learning communities at work, new insights for improving schools*. Bloomington, IN: Solution Tree.
- Earl, L. M., & Timperley, H. (Eds.). (2009). *Professional learning conversations: Challenges in using evidence for improvement*. New York: Springer.
- Feldman, M. S., & Pentland, G. T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly*, 48, 94–118.
- Firestone, W. A., & Gonzalez, R. A. (2007). Culture and processes affecting data use in school. In P. A. Moss (Ed.), *Evidence and decision making* (pp. 132–). Chicago, IL/Malden, MA: National Society for the Study of Education. Distributed by Blackwell Publishing.
- Fuchs, L. S., Fuchs, D., Karns, K., Hamlett, C. L., & Katz, M. (1999). Mathematics performance assessment in the classroom: Effects of teacher planning and student problem solving. *American Educational Research Journal*, 36, 609–646.
- Halverson, R., Grigg, J., Prichett, R., & Thomas, C. (2007). The new instructional leadership: Creating data-driven instructional systems in schools. *Journal of School Leadership*, 17(2), 158–193.
- Hamilton, L., Halverson, R., Jackson, S., Mandinach, E., Supovitz, J. A., & Wayman, J. C. (2009). *Using student achievement data to support instructional decision making* (No. NCEE 2009–4067). Washington, DC: National Center for Educational Evaluation and Regional Assistance Institute of Education Sciences US Department of Education.
- Herman, J., & Gribbons, B. (2001). *Lessons learned in using data to support school inquiry and continuous improvement: Final report to the Stuart Foundation*. Los Angeles: University of California, Center for the Study of Evaluation.
- Hill, H. (2001). Policy is not enough: Language and the interpretation of state standards. *American Educational Research Journal*, 38(2), 289–318.
- Honig, M., & Coburn, C. (2008). Evidence-based decision-making in school district central offices: Toward a policy and research agenda. *Educational Policy*, 22(4), 578–608.
- Honig, M. I., & Venkateswaran, N. (2012). School–central office relationships in evidence use: Understanding evidence use as a systems problem. *American Journal of Education*, 118(2), 199–222.
- Hord, S. M. (1997). Professional learning communities: What are they and why are they important? *Issues . . . About Change*, 6(1), 1–8 (revised) [http://www.sedl.org/change/issues/issue61/Issues\\_Vol6](http://www.sedl.org/change/issues/issue61/Issues_Vol6).
- Hoy, W. K., & Tschannen-Moran, M. (2003). The conceptualization and measurement of faculty trust in schools: The omnibus T-Scale. In W. K. Hoy & C. G. Miskel (Eds.), *Studies in leading and organizing schools* (pp. 181–208). Greenwich, CT: Information Age Publishing.
- Ikemoto, G. S., & Marsh, J. A. (2007). Cutting through the data-driven mantra: Different conceptions of data-driven decision making. *Yearbook of the National Society for the Study of Education*, 106(1), 105–131, (Chapter 5).
- Ingram, D., Louis, K. S., & Schroeder, R. G. (2004). Accountability policies and teacher decision making: Barriers to the use of data to improve practice. *Teachers College Record*, 106(6), 1258–1287.
- Kerr, K., Marsh, J., Ikemoto, G., Darilek, H., & Barney, H. (2006). Strategies to promote data use for instructional improvement: Actions, outcomes, and lessons from three urban districts. *American Journal of Education*, 112(4), 496–520.
- Knapp, M. S., Copland, M. A., & Swinnerton, J. A. (2007). Understanding the promise and dynamics of data-informed leadership. *Yearbook of the National Society for the Study of Education*, 106(1), 74–104, (Chapter 4).
- Kruse, S. D., & Seashore Louis, K. (1993). Developing professional communities in new and restructuring urban schools. *Paper presented at annual meeting of the University Council on Educational Administration* Retrieved 06.04.12 <http://www.eric.ed.gov/PDFS/ED366676.pdf>.
- Kruse, S., Seashore Louis, K., & Bryk, A. (1994). Building professional community in schools. *Issues in restructuring schools. Issue Report# 6* (pp. 3–6). Madison, WI: Center on Organization and Restructuring of Schools [http://www.wcer.wisc.edu/archive/core/issues\\_in\\_restructuring\\_schools/issues\\_no6\\_spring\\_1994.pdf](http://www.wcer.wisc.edu/archive/core/issues_in_restructuring_schools/issues_no6_spring_1994.pdf) (Spring).
- Kruse, S. D., Louis, K. S., & Bryk, A. S. (1995). An emerging framework for analyzing school-based professional community. In K. S. Louis & S. Kruse (Eds.), *Professionalism and community: Perspectives on reforming urban schools*. Long Oaks, CA: Corwin.
- Lachat, M. A., & Smith, S. (2005). Practices that support data use in urban high schools. *Journal of Education for Students Placed at Risk*, 10(3), 333–350.
- Lai, M., & McNaughton, S. (2009). Raising student achievement in poor communities through evidence-based conversations. In L. Earl & H. Timperley (Eds.), *Professional learning conversations: Challenges in using evidence for improvement* (pp. 13–27). New York: Springer.
- Lasky, S., Schaffer, G., & Hopkins, T. (2009). Learning to think and talk from evidence: Developing system-wide capacity for learning conversations. *Professional learning conversations: Challenges in using evidence for improvement* (pp. 95–107). Netherlands: Springer.
- Lasley, T. J. (2009). Using data to make critical choices. In T. J. Kowalski & T. J. Lasley (Eds.), *Handbook of data-based decision making in education*. New York: Routledge.
- Lomos, C., Hofman, R. H., & Bosker, R. J. (2011). Professional communities and student achievement—a meta-analysis. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice*, 22(2), 121–148.
- Little, J. W. (2012). Understanding data use practices among teachers: The contribution of micro-process studies. *American Journal of Education*, 118(2), 143–166.
- Little, J. W., & Curry, M. W. (2009). Structuring talk about teaching and learning: The use of evidence in protocol-based conversation. In L. M. Earl & H. Timperley (Eds.), *Professional learning conversations: Challenges in using evidence for improvement* (pp. 29–42). Dordrecht: Springer.
- Mandinach, E. B., & Jackson, S. S. (2012). *Transforming teaching and learning through data-driven decision making*. Thousand Oaks, CA: SAGE.
- Marsh, J. A. (2012). Interventions promoting educators' use of data: Research insights and gaps. *Teachers College Record*, 114(11), 1–48.
- Marsh, J. A., Pane, J. F., & Hamilton, L. S. (2006). *Making sense of data-driven decision making in education: Evidence from recent RAND research (OP-170)*. Santa Monica, CA: RAND Corporation.
- McLaughlin, M. W., & Talbert, J. E. (1993). *Contexts that matter for teaching and learning*. Palo Alto, CA: Context Center on Secondary School Teaching.
- McLaughlin, M. W., & Talbert, J. E. (2001). *Professional communities and the work of high school teaching*. Chicago: University of Chicago Press.
- McLaughlin, M. W., & Talbert, J. E. (2006). *Building school-based teacher learning communities: Professional strategies to improve student achievement*. New York: Teachers College Press.
- Means, B., Padilla, C., DeBarger, A., & Bakia, M. (2009). *Implementing data-informed decision making in schools—Teacher access, supports and use*. Menlo Park, CA: SRI International Report Prepared for U.S. Department of Education, Office of Planning, Evaluation and Policy Development.
- Nabors-Olah, L., Lawrence, N., & Riggan, M. (2010). Learning to learn from benchmark assessment data: How teachers analyze results. *Peabody Journal of Education*, 85(2), 226–245.
- Nelson, T. (2008). Teachers' collaborative inquiry and growth: Should we be optimistic? *Science Teacher Education*, 93, 548–580.
- Parr, J., & Timperley, H. (2008). Teachers, school and using evidence: Considerations of preparedness. *Assessment in Education: Principles, Policy and Practice*, 15(1), 57–71.
- Rosenholtz, S. (1989). *Teacher's workplace: The social organization of schools*. New York: Longman.
- Saunders, W. M., Goldenberg, C. N., & Gallimore, R. (2009). Increasing achievement by focusing grade-level teams on improving classroom learning: A prospective quasi-experimental study of Title I schools. *American Educational Research Journal*, 46(4), 1006–1033.
- Schildkamp, K., & Kuiper, W. (2010). Data informed curriculum reform: Which data, what purposes, and promoting and hindering factors. *Teaching and Teacher Education*, 26(3), 482–496.
- Senge, P. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Currency Doubleday.
- Sharkey, N. S., & Murnane, R. J. (2006). Tough choices in designing a formative assessment system. *American Journal of Education*, 112(4), 572–578.
- Sherer, J. Z., & Spillane, J. P. (2011). Constancy and change in work practice in schools: The role of organizational routines. *Teachers College Record*, 113(3), 657–661.
- Spillane, J., Reiser, B., & Reimer, T. (2002). Policy implementation and cognition. Reframing and refocusing implementation research. *Review of Educational Research*, 72(3), 387–431.
- Supovitz, J. A. (2002). Developing communities of instructional practice. *Teachers College Record*, 104(8), 1591–1626.
- Supovitz, J. A., & 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, University of Pennsylvania (November).
- Supovitz, J. A., Merrill, E., & Conger, M. (2010). Productive teacher use of student performance and related data in professional learning communities. *Paper presented at the American Educational Research Association annual conference*.
- Supovitz, J. A., & Morrison, K. (2011). Does collaboration facilitate data use in schools? *Paper presented at the annual meeting of the American Educational Research Association*.
- Timperley, H. (2009). Evidence-informed conversations making a difference to student achievement. In L. M. Earl & H. Timperley (Eds.), *Professional learning conversations: Challenges in using evidence for improvement* (pp. 69–79). New York: Springer.
- Van Lare, M. D., & Brazer, S. D. (2012). An examination of how teachers make sense of data in professional learning communities. *Paper presented at the annual meeting of the American Educational Research Association*.
- Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teacher practice and teacher learning. *Teaching and Teacher Education*, 24(1), 80–91.
- Wayman, J. C. (2005). Involving teachers in data-based decision-making: Using computer data systems to support teacher inquiry and reflection. *Journal of Education for Students Placed at Risk*, 10(3), 295–308.
- Wayman, J. C., & Cho, V. (2007). Preparing educators to effectively use student data systems. In T. J. Kowalski & T. J. Lasley (Eds.), *Handbook of data-based decision making in education* (pp. 89–104). New York: Routledge.
- Wayman, J. C., Cho, V., & Shaw, S. (2009). *Survey of educator data use* Unpublished document.

- Wayman, J. C., Cho, V., & Shaw, S. M. (2009). *First-year results from an efficacy study of the Acuity data system*. Austin: The University of Texas.
- Wayman, J. C., Jimerson, J. B., & Cho, V. (2012). Organizational considerations in establishing the data-informed district. *School Effectiveness and School Improvement: An International Journal of Research, Policy and Practice*, 23(2), 159–178.
- Wayman, J. C., & Stringfield, S. (2006). Technology supported involvement of entire faculties in examination of student data for instructional improvement. *American Journal of Education*, 112(4), 549–571.
- Weinbaum, E. (2009). *Learning about assessment. An evaluation of a ten-state effort to build assessment capacity in high schools*. Philadelphia, PA: Consortium for Policy Research in Education.
- Wohlstetter, P., Datnow, A., & Park, V. (2008). Creating a system for data-driven decision-making: Applying the principal-agent framework. *School Effectiveness and School Improvement*, 19(3), 239–259.
- Young, V. M. (2006). Teachers' use of data: Loose coupling, agenda setting, and team norms. *American Journal of Education*, 112(4), 521–548.

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