

Districts' efforts for data use and computer data systems: The role of sensemaking in system use and implementation

Authors: Vincent Cho, Jeffrey C. Wayman

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SYSTEMS

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The role of sensemaking in system use and implementation

Abstract

Aiming to support data-informed decision making among teachers, school districts have invested significant resources in computer data systems. Despite the potential benefits of these technologies, there is growing evidence that they may be underutilized. This comparative case study of three school districts aims to explore the factors affecting teachers' use of these systems. Using interview and observational data, we highlight the influence of sensemaking on practices around data systems. Although computer data systems offer an important first step to transformations in practice, we found that changes do not occur naturally. Changes to practice were not predetermined by the technologies themselves. Instead, we found that practices were driven by people and the unique meanings they attributed to data and to data systems. Although central offices were important to sensemaking, this role was often underplayed. Accordingly, we provide recommendations regarding how researchers and district leaders might better conceptualize about data and data systems.

Introduction

One commonly held belief is that technologies improve work. Faced with a task that is burdensome or time-consuming, we seek out tools that will make our efforts more productive. For example, the work of effective data-informed decision making has been portrayed as difficult without the benefits of computerization (Knapp, Swinnerton, Copland, & Monpas-Hubar, 2006; Means et al., 2009; Wayman & Stringfield, 2006; Wayman, Stringfield, & Yakimowski, 2004). Via computer data systems, teachers now have access to a variety of functionalities for enhancing their decisions about students. These include: the integration of longitudinal data; the disaggregation of that data by class, student, or other demographic factor; and the calculation of future performance (e.g., Brunner et al., 2005; Chen, Heritage, & Lee, 2005; Wayman, Cho, & Shaw, 2009). Thus, computers data systems may be seen as a natural remedy for the technical problems associated with data use.

For districts, such remedies may be in high demand. Standards-based accountability policies continue to elevate the importance of effective data use (Ingram, Louis, & Schroeder, 2004; Spillane, Parise, & Sherer, 2011; Valli & Buese, 2007), and districts have continued to increase their investment in data systems (Burch, 2010; Means, Padilla, DeBarger, & Bakia, 2009). Despite increased access to computer data systems, however, there is increasing evidence that data systems may be underutilized (Means et al., 2009; Wayman, Cho, & Johnston, 2007; Wayman, Cho, & Shaw, 2009). Contrary to the hope that such tools might become integral to teachers' everyday work, data systems seem to be used more sporadically.

If data systems can improve work, why have not districts' investments resulted in more widespread teacher use? We posit that providing access to appropriate data systems may be only a first step to supporting changes to practice. Although districts have attempted to address the

technical challenges associated with data use, they have yet to adequately attend to the social and interpretive dynamics underlying system implementation. Thus, our aim in the present study is to examine teachers' use of data systems by focusing on the role of sensemaking in system implementation.

Drawing upon the concept of interpretive flexibility (e.g., Leonardi, 2009; Pinch & Weibe, 1984; Winner, 1993), we examine understandings about data systems and how these might vary among social groupings, such as district or job role (i.e., central office member, campus administrator, and teacher). In doing so, we are guided by one fundamental research question: What factors affect teachers' use of computer data systems? To answer this question, we rely upon data from a comparative case study of three districts, juxtaposing how they and people in various roles conceived of data use and computer data systems.

Literature Review

To support our perspective, it is necessary to review the literature in two areas: computer data systems for examining student data, and the interpretive flexibility of technology. In the following narrative, we provide a section for each.

Computer Data Systems

In order to understand computer data systems, it is helpful to understand their prominence in data use. At the heart of data use initiatives is the premise that information about students can and should be leveraged in educational decisions. In line with Black and Wiliam's (1998) promotion of formative assessment, advocates for data use thus envision bringing together a wide variety of data as feedback about student learning (e.g., Bernhardt, 2008). Some of these data may include standardized end-of-year or interim tests, many of which are intended to align to state standards (Ingram et al., 2004; Polikoff, Porter, & Smithson, 2011; Spillane et al., 2011;

Stecher, Hamilton, & Gonzalez, 2003). Other commonly collected forms of data may include grades, attendance, portfolios of student work, and student demographic information (e.g., ethnicity, gender, or special needs status) (Lachat & Smith, 2005; Supovitz & Klein, 2003; Wayman & Stringfield, 2006).

It would be difficult, if not impossible, for educators to manage and analyze these many data sources without computer data systems. Wayman and colleagues (Wayman, Cho, & Richards, 2010; Wayman et al., 2004) provide overviews of some common characteristics of such systems, while others have described the use of particular systems in practice (e.g., Brunner et al., 2005; Chen, Heritage, & Lee, 2005; Wayman & Stringfield, 2006). Features that are increasingly available to teachers include: customized reporting for teachers or other audiences; information about individual student strengths and weaknesses; information about group- or classroom-level instructional needs; links to additional instructional resources; disaggregation by ethnicity, at-risk status, or other special program status; and longitudinal, diagnostic, or predictive calculations of student performance.

In this way, the potential of data systems has often been portrayed positively. Seeking a more robust understanding of student needs, educators have found it beneficial to draw from many sources of data at once, a task that can be uniquely supported via technologies (Lachat & Smith, 2005; Wayman & Stringfield, 2006). Touting the benefits of one particular system, Tucker (2010) exemplifies much of the optimism regarding how one “repository of statistical information about students” can lead to changes in teaching and learning:

With a couple of mouse clicks, classroom teachers can now get such data as interim test scores, subject grades, attendance records, and English language learner status on a single computer screen. Thanks to [this system], a high school instructor who may have a student for just one period a day can now see how that student is progressing across all courses, and can identify students at risk of academic failure. Teachers are now able to

spot long-term learning trends, even for students who moved often among schools and who have only just arrived in the class. (p. 2)

In the hopes of leveraging these sorts of technological advancements, districts' investment in computer data systems has continued to grow (Burch & Hayes, 2009; Means et al., 2009).

The conclusion that we draw from this literature base and from our own research experience is that data systems are typically portrayed as having fixed, predetermined "effects" on work. Obscuring the importance of contextual factors, this view assumes a linear relationship between what gets designed and what happens in practice. Indeed, implementing these systems may be more complicated than previously assumed. There is increasing evidence that data systems may be underutilized by teachers (Means et al., 2009; Wayman, Cho, & Johnston, 2007; Wayman et al., 2009). The list of challenges in this area can be quite lengthy. It includes: teacher dissatisfaction with the available data or its timeliness; trouble finding the data desired; lack of familiarity with the data and its potential uses; and ease of system use.

One potential solution to this problem lies in examining the ways that educators make sense of and interpret the uses of these data systems. In fact, in more general studies of data use, a shift toward focusing on social and interpretive issues (i.e. sensemaking) has begun. The implementation of policy has been found to be influenced by variations in interpretive processes (Datnow, 2006; Palmer & Snodgrass Rangel, 2011; Spillane, Reiser, & Reimer, 2002), and calls to apply similar lenses toward data use have continued to mount (Coburn & Turner, 2011; Honig & Venkateswaran, 2012; Young, 2006). Although computer data systems are a key lever to current efforts for data use, we are unaware of any study that has specifically addressed sensemaking issues around these technologies.

Ways to begin to understand sensemaking about technologies, however, are prevalent in fields such as Information Systems (IS) and Management Information Systems (MIS). One example of this is the notion of interpretive flexibility. In the following section, we draw upon scholarship in these fields to explore this notion.

The Interpretive Flexibility of Technology

One issue at stake in studying technologies and their use involves whether they have predetermined outcomes for organizations. Technologically deterministic perspectives tend to portray technologies as if they are imbued with preset goals and “effects” on work (e.g., Barley, 1990; Orlikowski & Iacono, 2001). Thus, making work faster, less burdensome, or more efficient is assumed to be a matter of putting the right tools in the right places.

The notion of interpretive flexibility affords a departure from such assumptions. It begins by recognizing that social groups can have different values, expectations, and beliefs about the world.¹ Originating in the scholarship on the Social Construction of Technology (SCOT) (e.g., Pinch & Weibe, 1984; Winner, 1993), interpretive flexibility suggests that technological artifacts can carry different meanings for different social groups. Therefore, although designers and planners may have certain hopes for the use of computer data systems, interpretive flexibility suggests that the “reality” of the artifact is determined by users and their social interactions. When viewed across social groups, the significance and purposes of a technology can be seen as varying. This contrasts with current frames of understanding in the scholarship on data systems.

In the light of interpretive flexibility, technological artifacts are not neutral, nor are they imbued with fixed, universal meanings. Rather, users' values, interests, and assumptions shape

¹ Drawing upon other studies of technologies and organizing (e.g., Bailey & Barley, 2011; Barley, 1990; Carlile, 2002), our definition of social group includes job role as well as organization at large.

the experience and enactment of a technology (Leonardi, 2009; Markus & Robey, 1998; Orlikowski & Barley, 2001; Orlikowski & Iacono, 2001). In short, technologies are not simply machines, dropped into organizations without the need to account for sensemaking. Instead, each exists in a particular time and place, among particular sets of people. Technologies are not simply “the computer.” Rather, the burden on researchers is to attend to the narratives, social interactions, and experimentation involved in their use (Barley, 1990; Brown & Duguid, 1991; Davidson & Chismar, 2007; Orlikowski, 1996). This sheds light on what technologies really mean to work. Consequently, interpretive flexibility leads one to locate agency for changes to work not in tools, but in people.

For educational researchers, interpretive flexibility affords a useful way to conceptualize computer data systems, as well as the data they afford. Examining the meanings of data systems across districts or roles within districts (i.e. social groups) can help to illuminate why data systems might be underutilized. For example, some district leaders or vendors might be surprised when a powerful, easy to use tool fails to make the impact on teachers' data use that they had envisioned. Whereas a natural response might be to doubt the tool or its design, a better response might be to investigate what sense teachers have made of those artifacts. If leaders or vendors are surprised, it might be because they neglected to realize that teachers' visions about a system's fit to practice could be different from their own. In this manner, interpretive flexibility sheds light on social and organizational issues in district data initiatives.

Methods

The notion of interpretive flexibility allows us to attend to the ways in which meanings around data and around computer data systems might vary according to social groupings. The social groups examined in this study were school districts and job roles within districts. Each

school district was considered its own case, or bounded system (Merriam, 2009; Stake, 1995), with the roles of central office member, campus administrator, and teacher embedded within them. We use the term “people” to describe these groups all together, without reference to role.

Study Districts

Data were collected in three districts in Texas.² Boyer School District was a high-achieving district of approximately 8,000 students that mostly served a non-Latino White population,³ less than five percent of whom were economically disadvantaged. Gibson School District was a district of mid-range achievement that served approximately 25,000 students of various ethnic backgrounds,⁴ half of whom were economically disadvantaged. Musial School District was a district of mixed achievement that served approximately 45,000 students of various ethnic backgrounds,⁵ a third of whom were economically disadvantaged. These districts were not known for (or selected because of) their success at using data.

These districts were subject to the Texas Assessment of Knowledge and Skills (TAKS) test, the statewide criterion referenced accountability test. Other assessments used by each district, however, varied. For example, Musial used district-wide benchmark tests, which were intended to align to the state test. Gibson, however, used interim assessments that were intended to align to specific curriculum units and lesson objectives that teachers were expected to have taught. Boyer used benchmark tests but these were rarely mentioned by participants.

Wayman and colleagues (Wayman et al., 2004; Wayman et al., 2010) have reviewed some of the categories of data systems currently available to school districts. Although the

² Pseudonyms are used for each district.

³ 80% non-Latino White, 10% Latino.

⁴ 40% Latino, 30% non-Latino White, 20% African American.

⁵ 50% non-Latino White, 25% Latino, 10% African American.

districts in this study had multiple data systems, two were especially important to the present study. The first was Front End,⁶ which had been designed by the Musial district's technology department in coordination with a teacher user group and the associate director for data use. It was new to the teachers in this study. Before the advent of Front End, site licensing issues had prevented teachers from direct access to student data. Front End drew upon a wide assortment of data from the district's data warehouse. This was considered an advancement over the district's previous practice of emailing large Excel spreadsheets of student data.

The second was Flightpath, an assessment system that was present in two districts. In Gibson, Flightpath had been in use for teacher appraisal data. During our study, it was being expanded to become an assessment system, delivering data from state tests, the district's interim assessments, and tests designed at the campus level. In Boyer, Flightpath was offered district-wide for handling state test and district benchmark data.

Data Collection

Data collection took place from March 2010 to January 2011. Data sources included interviews (e.g. individual interviews and focus groups) and observations. In total, 82 central office members, campus administrators, and teachers participated in individual interviews or focus groups. Generally, central office members participated in interviews individually and campus-level educators participated in focus groups.

Our interview sampling was aimed at developing a sense for the unique perspectives of job roles within each district. The sample of central office began with a start list that then

⁶ Pseudonyms are used for each system.

expanded based upon other participants' recommendations about other potentially important or knowledgeable informants. Seventeen central office members were interviewed in total.

The sample of campus-level educators began by choosing one high school, middle school, and elementary school at random from each district (nine schools overall). In each school, two focus groups were conducted, one for administrative teams and the other for teachers. Principals were asked to participate in their campus's administrator focus group and chose members of their administrative team that could contribute to the conversation. Teachers were selected from each campus at random, with checks to ensure a variety of grade levels or content areas. Teacher focus groups typically consisted of four to six teachers. In all, nineteen campus administrators and 46 teachers participated in focus groups.

Before beginning each interview (individual or focus group), participants were informed about our interest in their uses of data and computer data systems. They were informed that their remarks would be anonymized, but that in aggregate their insights could contribute to recommendations for each district or for the field at large. All interviews were recorded and transcribed. Following semi-structured protocols (e.g., Merriam, 2009; Miles & Huberman, 1994; Weiss, 1994), examples of our lines of inquiry included: What has the district been doing this year to improve data use? How are you seeing teachers using data? Which computer data systems are most beneficial to teachers? Which functions are most typically used; which are favorites? How do data systems inform practice?

Observational data helped to provide a first-hand sense for how districts were introducing and dealing with computer data systems. The venues included trainings for computer data systems, leadership events (e.g., principals' meetings), and meetings of central office planners. Observations offered a glimpse into how people perceived data systems, challenges to

implementation, and why data systems might be important to practice. At each field experience, comprehensive sets of jottings were collected that were later be expanded and knit into more detailed field notes (Emerson, Fretz, & Shaw, 1995). Following the recommendation of Lareau (2000), this process typically occurred within one day. Fifteen observational sessions were conducted, each lasting between one hour to several hours. These observational data were a way to enrich and triangulate interview data (Yin, 2009), but were not considered to represent the district *in toto*.

Data Analysis

Data analysis was interspersed with data collection, which facilitated attention to key constructs as they emerged (Bosk, 2003; Merriam, 2009). Using Atlas.ti, we began with a start list of constructs (Eisenhardt, 1989; Miles & Huberman, 1994), stabilizing our codes after several iterations. Codes provided a sense for what people thought data was, what they considered data to be good for, districts' efforts around data, and other similar issues relating to computer data systems. From these, we developed case portraits (Yin, 2009) for each district, attending to how each role within each district conceived of data and computer data systems. Because our research question related to the factors affecting teachers' use of computer data systems, our analysis attended especially to teachers' unique perspectives and how these tied into broader organizational issues.

In this, matrices (Eisenhardt, 1989; Miles & Huberman, 1994) were especially helpful during analysis. In simple terms, matrices are tables with rows and columns. For instance, a within-district matrix for job roles' perspectives about data systems would begin with the data for a single district. Job roles would comprise the rows of the matrix and themes or issues of interest would comprise the columns. For this example, rows included central office members,

campus administrators, and teachers. Columns included characterizations about data systems, which functionalities were actually used, and perceptions training or other district structures. Thus, the first cell would include a short summary of how central office members conceived of their data systems. In this way, cells could be compared within themes by role and vice versa.

Subsequently, additional within-district matrices were created for the other districts and issues of interest. Aiming to generate insights about matters that might span the three districts, within-district matrices were then compared to or combined with each other. In this, a “replication logic” helped us to seek out why some patterns might hold while others might fail (Yin, 2009).

Results

The notion of interpretive flexibility allowed us to attend to the ways in which meanings around data and around computer data systems might vary according to social groupings. Comparing and juxtaposing issues from each set of perspectives yielded insights into patterns that spanned groups and how particular among issues had organizational consequences. Because our research question related to the factors affecting teachers' use of computer data systems, we gave special attention to teachers' unique perspectives and how they fit into other organizational issues.

Through these analyses, we found that teachers' sense and enactment of data systems were grounded in their unique notions about “data” and “data use.” Further, we found that these notions were consistent based on their educational social group (i.e., their district or their role) and that the actions and messages of central office could play a role in how these notions developed. We present our findings in four sections: (1) Notions about data, (2) Making sense of

computer data systems, (3) Teachers' enactment of computer data systems, and (4) The influence of central office.

Notions About Data

In order to understand the factors influencing teachers' uses of computer data systems, we first explored the district contexts for system use. In particular, we began by examining whether people in each district and each role similarly conceptualized about "data" and "data use." If the natures of data and data use were fixed, then we would have expected to find similar notions about concepts such as which data were most useful, what data are good for, and why data ought to be used.

Instead, we found a diversity of notions about data, many of them closely associated with district or role. This complicated the landscape in which teachers were expected to use computer data systems and which other roles were expected to support their implementation. In the two cases of Musial and Gibson, notions about data were internally consistent throughout each district, regardless of role. Boyer, however, was particularly fragmented and without consensus. There, characterizations of "data" and "data use" were most clearly delineated by role. In the following sections, we will discuss notions of data in each of our three study districts.

Musial's notions about data. The Musial district's perspective was deeply tied to the goal of improving according to accountability rankings. Regardless of campus or central office department, "success" for both students and the district was described as increasing achievement in state rankings and state test scores.

In Musial, "data use" was consistently framed within these larger aims. The district superintendent was invested in these notions. For example, his opening address at the district leadership retreat was on "evidence of success" and culminated in publicly applauding various

school leadership teams. Those that were asked to stand included those with high overall state test passing rates, jumps in state ranking, or notable percent increases in passing rates.

Central office and campus administrators also saw accountability measures as necessary to improving student learning. Central office members saw accountability measures as a way to make achievement evident. As one central office member explained, “[The state test] is how the state measures mastery and proficiency of its curriculum... [student achievement] is not really negotiable for our district.” Throughout central office, participants described success according to these measures as a duty they owed to the state, to the local community, or to parents. In line with these attitudes, campus administrators saw these measures as vehicles for closing achievement gaps. They especially valued linking state standards to demographic data. As one Musial principal explained, the accountability system afforded a “special, laser-like focus on students,” ensuring that less students might “fall through the cracks.”

Although some teachers believed that data and the best uses of data systems extended beyond accountability, most talked about state test data when it came to “data use.” Other forms of data were rarely mentioned. Indeed, teachers’ most frequently mentioned practice using data was to “look at” state test results, noting overall categories of achievement such as tallies of students passing, failing, or scoring at the “commended” level. They considered this as providing a general awareness about student needs. It also began the process of sorting of students into groups, such as for tutorials or other assistance. None described using this data for individualized instructional practices (e.g., tailoring lessons or attention for particular students). Even those that found this dynamic lamentable conceded that it was just the way things were. As one teacher said:

Do they know where our kids are in terms of the [state test] scores? They know that. They have projections on whether we'll be exemplary or recognized or whatever based on those scores. But do they know what they need to do to help us improve our instruction? I'm not really sure.

Gibson's notions about data. The Gibson district's perspective was aligned around the notion of "student expectations," commonly referred to as the "SEs." The difference between the SEs and state standards was in their granularity. The SEs constituted specific components of larger objectives. These provided the basis from which teachers were expected to design activities.

In this light, "data" could take on many forms. Rather than be limited to a particular test, the object of interest was feedback for practice. The superintendent named two benefits to this approach over one focusing on the state test. First, he believed that data at the SE-level was more actionable. Second, he believed that it opened up larger conversations for educators about instructional practices, lesson content, and degrees of instructional rigor. His belief was that offering students a broader range of learning experiences could come first, and that state test requirements could be fulfilled along the way.

One form of SE data that was common to all Gibson schools was the district interim assessments. These were designed to target particular SEs found in the district curriculum units, such that they could provide feedback about practice. In the words of one central office member:

The [interim assessments] were generated to inform instruction. If you've taught this curriculum, the material in the curriculum of [our district], and your students take this test that's directly aligned with the curriculum... We want you as a teacher to look at the results to determine how well the students mastered the curriculum that you just taught over the last nine weeks.

Thus, the Gibson perspective stood in contrast to the one in Musial. Although both districts saw data use as important to serving students, data use in Musial took on the character of state test

and accountability measures, while data use in Gibson was oriented toward locally-designed, shorter cycle feedback.

Although educators throughout Gibson saw attention to the SEs as important, they also recognized that the district interim assessments were not the only source for this sort of feedback. In fact, all roles admitted that there were challenges associated with the interim assessments. Many of these related to agreeing about the content of the assessments or to maintaining the teaching pace suggested by curriculum guides.

These were seen, however, not as pitfalls for attending to the SEs, but as motivations to use other sources of data about the SEs. For example, one principal encouraged her teachers to create common assessments that were tied to the SEs. She lauded that that these common assessments were more reflective of the SEs and more timely than the interim assessments. Similarly, although teachers mentioned the use of state test data for large-group and early-in-the-year decisions, they also described using SE-level data for informing classroom instructional practices. Examples of this included quizzes and SE-based “exit-tickets” about a day’s lesson, both of which might be used in collaboration with colleagues.

Boyer’s notions about data. In contrast with the preceding districts, there were clear divisions among roles in the Boyer district regarding perspectives on data. For example, central office members felt that data should be thought of holistically. At the cabinet level, the opinion was that “everything informs,” but that not all data were being used insightfully. Accordingly, cabinet members began to promote the need for what they called “*informative assessment*” at central office meetings, principals’ meetings, and the opening of the year address. Other central office members echoed that each data point was a “piece of the puzzle” about the “whole student.”

For the most part, the Boyer central office notion of data use centered around this level of general awareness about students. Rarely did central office members discuss data in terms of specific educational practices. Rather, they emphasized understanding about the needs, motivations, and histories of students. This was even so when describing the need to target certain kinds of students. For example, central office members designed and implemented trainings for data use at each campus that were intended to impress upon teachers the importance of using data holistically. Specifically, they provided teacher teams with the data for three individual students, each representing a target group: students who excelled, economically disadvantaged students, and students who struggled academically. Teachers were asked to examine the data and to make inferences about the student's history of school experiences.

In contrast, campus administrators saw data more specifically in terms of practice. They saw data as being important to meeting individual students' needs. One described this as choosing "the right kids to work with on the right objectives at the right time." They also saw data as supporting programmatic decisions, such as when designing interventions for struggling students or making course scheduling decisions. Campus administrators did not make mention of "informative assessment" or the need to enrich one's understanding of the whole student via data.

Teachers presented yet another view about data. As found throughout Musial, the general sentiment from Boyer teachers was that "data" was about testing. Unlike Musial, Boyer teachers did not focus on any particular test. Teachers at different levels named different tests, with the common thread being that teachers were required to give students assessments, but not to systematically reflect or act upon their results. In other words, Boyer teachers viewed "data" as being about compliance and reporting information to central office, not necessarily "use."

Overall, teachers felt that “data” failed to capture what they knew in their “heart of hearts” about students. As one teacher lamented:

There was a day when a lot of worth was placed on the intuitiveness of a classroom teacher. We couldn't really put it down in numbers necessarily, but we knew a lot. [From this,] you could function on what you knew. So that'll leave a bad taste in your mouth about data. I just want my focus to be teaching these kids, and I trust my intuition to do that.

Another teacher described this in terms of being able to adapt lessons to students' interests. She felt that her classroom was “so amazing and so different” when she re-arranged her teaching this way, and not according to “information on a piece of paper.” In short, Boyer teachers tended to describe teaching if it was an art that was not readily amenable to being driven by “data.”

Accordingly, teachers found routine classroom data most informative. These data included grades, running records, and portfolios of student work.

Making Sense Out of Computer Data Systems

Given that notions about data were differed among social groups, we next examined if notions about computer data systems also varied. If technologies had predetermined meanings, then we would have found similar ideas about what particular systems “were about,” regardless of social grouping. Instead, we found that understandings about systems varied. This depended upon groups' preconceived notions about data use. This dynamic played a part in users' satisfaction with systems. In the following narrative, we will discuss these notions in terms of interpretive flexibility and value judgments about data systems.

Interpretive flexibility and notions about data use. As described in our literature review, the notion of interpretive flexibility represents a departure from technologically deterministic assumptions about technology. It suggests that the same technological artifact can mean different things to different social groups (e.g., Leonardi, 2009; Orlikowski & Iacono,

2001; Pinch & Weibe, 1984). In this study, we were interested in the social groupings of district or of role. Thus, we examined whether districts or roles with access to the same computer data systems saw these technologies in similar or different ways.

Findings about the Flightpath system were particularly informative because it was present in both the Gibson and Boyer. Thus, we were able to examine understandings about Flightpath across the two districts and across their individual role groups (i.e. central office member, campus administrator, teacher). Viewed through the lens of technological determinism, one would assume the significance of Flightpath would be the same everywhere, regardless of district or role. However, this was not the case. In line with interpretive flexibility, the technology did not of its own accord determine how a system was understood or used – notions about data did.

Further, we found that it was coherency around those notions about data that determined how understandings about computer data systems might vary. For example, notions about data cohered at the district level in Gibson, but only at the role level in Boyer. Thus, although Flightpath was similarly available in both districts, we found four divergent ways for understanding how and why it ought to be used. One was at the Gibson district level. Regardless of role, Gibson educators characterized Flightpath as a tool for adjusting practice according to the SEs. This view can be contrasted with the three in Boyer. Boyer central office members thought of Flightpath as a distinct tool, with unique contributions toward seeing the whole student. In contrast, Boyer campus administrators had trouble distinguishing Flightpath from other systems in the district. Boyer teachers thought of Flightpath as something to be used only in so far as central office mandates required.

Thus, divisions in understandings about Flightpath were associated with role group, but whether that grouping was by district or by role depended upon respective notions about data.

This pattern was supported by findings in Musial, even though it did not use Flightpath. In Musial, notions about data use cohered at the district level, as did understandings about Front End.

In other words, we found understandings about data systems to be embedded in notions about data use. “Data use” served as an interpretive lens for educators. This lens influenced not only not only the how and why of data systems, but also judgments about how well those systems fit work.

Judgments about the fit of systems. In order to determine how meanings around data systems might be embedded in notions about data use, we compared each set of notions about data use (e.g., data as being about accountability rankings; data as being about SEs) to descriptions of why and how particular data systems fit work. It became evident that notions about data served as users’ interpretive lenses, giving them expectations for what ought to be in systems and leading them to make value judgments about their systems.

Not surprisingly, users were most satisfied with their systems when their expectations were met. Overall, educators in the Musial and Gibson districts were most satisfied with their systems. Just as one might take it as a given that light bulbs produce light, they tended to take it as a given that their data systems gave them the data they expected. Because educators in each district had particular notions about what constituted data and data use, those were the data they oriented to in their systems. More specifically, teachers in Musial (where accountability data were prioritized) used Front End to access accountability data. Teachers in Musial reported creating reports about students based upon their rankings on state tests. In the words of one teacher, “I do love Front End. I love being able to read and to have that resource. [After I have

had some personal time with students], I'll go and look at it... My push is to make sure that everybody is not just passing, but that also at commended [status].”

Teachers in Gibson (where progress on SEs was prioritized) used Flightpath to access and monitor progress on the SEs. One Gibson teacher spoke at length:

What I like about using Flightpath is that you can break down by student, by class, by teacher, by school, by district. You can break data down into many different categories, but it makes it easy to see exactly which SE, teacher, and students were low and which ones did well. [Item analyses] give you a really good understanding of what they understand and what they don't, and they show you misconceptions as well.

Not all users, however, felt that they were able to get what they wanted from their data systems. This took the form of a mismatch between notions about data use and real or perceived system limitations and resulted in critiques. For example, a handful of Musial teachers dissented from their colleagues regarding the value of Front End. These particular teachers considered data and data use to be important for daily instructional practice and believed the state tests were inadequate for this purpose. Rather than state test data, they wanted “real feedback about performance.”

In Boyer, where teachers were generally dismissive of test data in favor of information from regular classroom activities, teachers were also generally critical of their data systems. This was so not only for Flightpath, but also most other systems. Teachers described using systems when mandated, but did not consider them relevant to practice. Generally, Boyer teachers did not perceive that the data offered in their systems would be valuable, and this influenced opinions about the systems themselves. An exception to this was the district's online gradebook, which many teachers felt fit well into their daily practices. In the words of one teacher, “It's what we're doing every day, if not every period.” They described using the online gradebook to determine student needs, as well as to collaborate with parents or other teachers. This form of technology

use was in accord with Boyer teachers' overall attitude that the data from daily classroom activities were most valuable.

Finally, it should be recalled that the Boyer district was fragmented by role in its notions about data and computer data systems. This fragmentation also influenced notions of fit. Most notably, central office members felt that data use involved drawing upon many streams of data and that their systems supported this. Thus, central office opinions about the fit of data systems to work stood in contrast with the opinions held by the teachers who were actually expected to use the systems. No central office members in Boyer seemed aware that the online gradebook was the system favored by their teachers for regular feedback about students.

Teachers' Enactment of Certain Features in Computer Data Systems

Having found that notions about data use framed how users conceived of and evaluated their systems, we further focused on what this meant for teachers' actual uses of systems. As described previously, technologically deterministic perspectives tend to assume that technologies have predefined "effects" on work. In other words, having access to data systems would be assumed to result in expanded data use practices universally, regardless of social context. If they do not, then it is assumed that better, more powerful, or more desirable features must be needed. Contrary to these perspectives, we did not find that simple access to functionalities resulted in use. Rather, notions about data use served as an interpretive lens through which certain features were favored, while others were ignored or rejected.

Each data system offered a host of features and functionalities, from which teachers used only a few. For example, as Musial personnel developed the Front End system, they took care to attend to feedback from the district's teacher user group and associate director for data use. Consequently, Front End provided teachers with a number of features they had asked for, such as direct and timely access to data about state test results, student attendance, tardies, discipline, and district benchmark test scores. Despite the potential desirability of these features, they were rarely mentioned in our interviews. Instead, it was accountability data (e.g., state test passing/failing rates or "commended" levels) that teachers actually used. In accord with their district's notions about data, Musial teachers used their system to generate lists of students to target for academic support according to accountability standards. In the words of one teacher:

It kind of let me know who is at risk and which kids struggle. I definitely want them up front... I mean I know that my kids struggle all the time, but it just lets me know which ones I need to focus more attention on... [Front End] let me know their reading levels. Where are they reading at? Have they failed tests in the past? These are kids I really need to focus on.

A similar pattern could be found in Gibson, which was expanding Flightpath to also handle assessment data. Whereas Flightpath had only been used for teacher appraisal data, it now offered SE-level data for state test and district benchmark tests for each student and class. Moreover, it supported the automatic creation of tutorial reports based upon individual student performance. One important reason behind Flightpath's expansion was teacher demand for features that allowed them to scan and instantly analyze locally-designed data (e.g., classroom assignments or subject area common assessments). Despite the potential desirability of these features, however, it was the SE-level data from state test and district benchmarks that teachers actually used, in accord with their district's notions about data. For example, one explained:

I show my kids a lot of the data. I let them actually see it so it connects with them. Our warm-ups are mostly missed questions from the [district benchmark test]. I put the data underneath my book on my projector, [review data about students' previous responses,] and talk through the question. I use it a lot.

This pattern presented a paradox. Although teachers mentioned these various features favorably, they reported only using certain ones. Simple access, even to desirable features, was not enough. We interpreted these findings to suggest that notions about data use illuminated certain system features, while making it easier to ignore others. In effect, general knowledge about a feature did not necessarily result in making it a priority for practice. This explanation could also be extended to the teachers in Boyer. Because these teachers saw “data” as being a thing to collect and report, but not necessarily to use, many felt comfortable rejecting systems wholesale. They did as much as it would take to comply with central office mandates (i.e. priorities). The exception to this was their use of the online gradebook, which fit into their personal priorities at work.

The Influence of Central Office

Sensemaking shaped teachers' enactment of computer data systems, but we found that central office could play a hand in teachers' sensemaking. First, we have shown that the message emanating from central office regarding which data to prioritize and value often went on to shape teachers' notions. Second, although central offices took actions to support the use of data systems, these did not typically target teachers' sensemaking about data systems. In the following narrative, we present a section on both of these findings.

Messages about data from central office. In previous sections, we demonstrated that district messages played a part in one's notions about data. In this section, we summarize these results in terms of the central office.

In the Gibson and Musial districts, there was a strong message from central office regarding which data were to be prioritized: SE data in Gibson and state test data in Musial. And, teachers in these districts most often described data and data use in these terms. This was true despite comments from teachers indicating that other data could also prove valuable. Thus, the foregrounding of SE and state test data in Gibson and Musial (respectively) seemed to have a strong effect on how teachers conceptualized about data – and consequently, what they saw in and used in their data systems.

Conversely, there was no strong, unified message emanating from the Boyer central office about which data were most important. Their perspectives regarding data ranged from “everything informs” and “*informative assessment*” to attending to the “whole student.” Accordingly, we observed varied notions about data and data use (notions that were fragmented by job role). These notions were coupled with similarly disparate views and uses of data systems.

Central office supports for data systems. Teachers and central office personnel reported different views about the level and value of support offered by central office for data system use. Teachers in all three districts typically reported that central office did not do enough to help them gain value from their data system. Despite these assertions, however, we observed and heard central office report about their efforts aimed at this goal. This disagreement can be accounted for by comparing teachers' views about central office support to central offices' assumptions about what was needed. In the following, we offer a section on both.

Teachers' views about central office support. Although teachers were often clear about their central offices' efforts around data use, the same could not be said about data systems. For example, teachers in Musial readily spoke about their central office's efforts to focus their attention on state test performance. But it was a different story for computer data systems. Most

teachers in the district were expected to learn about Front End via “online training modules” (i.e. Powerpoint slides). Even when pressed, these teachers could not describe any support from central office about how to use Front End. They described being provided access to the system, with formal support from the school and central office stopping there.⁷ In fact, a common way for teachers to describe having learned to use Front End was via experimenting on their own or via pulling a colleague aside for help.

When asked about their district’s support for data use, teachers in Gibson were of mixed opinions ranging from negative to positive. Some were put off by having to deal with “stacks of data,” such as special education paperwork or hand-copying data from file folders. Others were quite positive about the involvement of central office. For example, one group especially was positive about how conversations with central office members and instructional coaches helped them to rethink their instructional and data use practices. When it came to the support for computer data systems, however, teachers were less positive. One group used the term “cognitive dump” to describe trainings, lamenting that there was little support beyond being told about some potential benefits and how to log-in. Another group called it the “here it is, now go” approach, expressing the wish that they might have trainings more regularly, such that skills might be deepened over time.

A similar pattern was seen in Boyer. Teachers saw central office as offering some trainings for data use, but described little support for the use of computer data systems. They characterized central office as requiring that data be “produced” (i.e. via monthly or bi-weekly

⁷ The exception to this came from our observational data of one-time Front End trainings for some specialized teachers (e.g., the teacher user group or teachers of gifted students). Although they were positive about the system and their support, they were not representative of the district at large. When asked, none of the teachers in our focus groups reported contact with the associate director for data use or other forms of central office support.

assessments) and then turned in. At trainings, they were “shown” data but not instructed on how to use it. When it came to computer data systems, they described no expectations about their use. Some were frank about how they were required to use systems to upload data, but not for other purposes. For the most part, which systems they used, and how, was up to them.

Central offices' assumptions about computer data system support. Teachers' portrayal of their central offices might lead one to conclude that not much was being done about computer data systems in these districts. To the contrary, much was being done, but little of it was about influencing teachers' sensemaking about computer data systems or their potential contributions to practice.

Interviews and observations collected from central offices revealed their attention to data systems to be focused on technical and logistical issues. These included ensuring that systems ran smoothly, that systems had desirable features, and that teachers received a basic overview for the technical side to system use (e.g., how to log in and find certain data). Although only Gibson central office members used this term, an attitude of “deployment” generally characterized central office's approaches to data systems. Formal attention was rarely given to how or why particular features might be meaningful to particular classroom practices. Regardless of district, the common assumption seemed to be that the repertoire of benefits from data systems would be self-evident.

We saw this in several ways. For example, the Musial district created the associate director for data use position for supporting data use and the creation of Front End. Although this person worked with principals and conducted some trainings for certain teachers, most of the district was expected to learn Front End by viewing the online training modules. Similarly, the Gibson central office attempted to support Flightpath via short trainings at school campuses. This

was seen as being sufficient because Flightpath was similar to its predecessor and had been in use for teacher appraisal. Neither of these central offices questioned whether the full depth and breadth of these systems would be used, nor did they expect the need for following up with teachers on how to embed systems in regular practice.

The Boyer central office was similar in believing that how to best use systems would be self-evident. Their view that “everything informs,” however, meant that they emphasized many systems at once. At the same time, the Boyer central office treated the use of computer systems as if it was a minor component to data use.

On one hand, they treated systems as easily interchangeable for each other. To the chagrin of a few teachers and principals, funding for data systems that were not widely used or that were considered redundant was cut at the beginning of the year. The expectation from central office was that the remaining systems could perform the tasks just as well.

On the other hand, Boyer central office members considered the integration of data by hand to be analogous to the use of an integrated data system. For example, central office trainings for data use involved delivering teachers with paper printouts from various systems. Central office members envisioned teachers accessing each system for its unique benefits, then integrating the information on their own. Although there had been some consideration of purchasing an integrated data system for the district, this eventually determined unnecessary. While cost played a factor in this determination, one central office member considered this “human resources solution” to be better than a data system. He asserted that using instructional coaches to print out and otherwise assist teachers might improve teachers' quality of data use.

Discussion

The question framing this article related to the factors affecting teachers' use of computer data systems. To address this question, we drew upon issues around sensemaking, particularly the notion of interpretive flexibility. This helped to illuminate that the ways in which data systems are used or ignored springs from users' notions about "data use."

Sensemaking about data systems was structured by notions about data and how data should be used to support instruction. In turn, these notions were influenced by signals emanating from central office. Peoples' notions cohered within social groupings (i.e. district or job role), serving as interpretive lenses for systems. Where there was a clear message (Gibson and Musial), social grouping did not matter beyond district. But where messages were unclear (Boyer), the sense that people made was distinguishable by role.

We did not find that technologies were agents of change to work of their own accord. In fact, even functions that teachers considered potentially beneficial might not actually be applied in practice. Rather, we located agency in educators' sensemaking about data and data systems. These processes explained how functions were favored, ignored, or rejected in practice. Subsequently, we saw room for central offices to assume less about the obviousness of the benefits of computer data systems. More could have been done to support and shape teachers' understandings about data systems. In the following sections, we discuss how this may be done by considering broader notions about data use, understanding that the technology may not bring about change on its own, and the importance of redefining technology implementation.

Certain Notions About "Data Use" Are Not a Given

Our study illuminated the variety of notions, definitions, and uses for data that may exist within districts or within roles. Further, our study showed that educator interaction with technology was shaped – and thus varied – by these notions. We believe it is thus important to

explore how this phenomenon extends beyond technology. That is, to understand how “data use” can best inform educational practice, it is important to first understand the variety of notions of what “data use” is and how these notions affect practice. For example, policies such as No Child Left Behind have made it easy to equate “data use” with accountability, but it is inappropriate to stop there. Only one of our three study districts saw data use as an accountability driven phenomenon. There were other lenses, which varied by context.

Thus, we emphasize the need for scholars to provide an emic account of educators' perspectives on data. Accordingly, the burden for researchers is to determine participants' own definitions and priorities for data and relate these dynamics back to the phenomena under examination. In doing so, researchers should be better able to identify how participants locate data in their professional decision making.

Our data suggests that many of these personal accounts will be consistent based on social grouping, as suggested by research relating to technologies and their interpretive flexibility (e.g., Bailey & Barley, 2011; Barley, 1990; Carlile, 2002). Thus, the current study provides a bridge for researchers to continue examining the role of social groupings in data use, both along the categories in this study and other forms of grouping. For example, teachers also interact with grade level or subject area teams, entire faculties, and school leadership teams. Methodological shifts might illuminate patterns of meaning even further. As Daly (in press) argues, social networking analysis could offer a beneficial lens for examining the pathways by which certain understandings about data use pass through schools. Contextualizing data use in this manner would help to illuminate the unique circumstances that contribute to changes in practice.

Technologies Occasion (But Do Not Determine) Change

The underlying promise of computer data systems is that they will naturally change schooling by their very presence. The advancements in computing power and ease of access are assumed to be enough. Our findings suggest, however, that the agency in transformations to practice continues to rest in people. While providing access to data systems might be an important first step, the introduction of a system did not necessarily result in innovations to practice. Additionally, certain features were favored, while others were ignored or rejected.

Indeed, we found it exceedingly rare for a teacher to mention having used or experimented with a system function just because it was there. In accord with structuration theory (e.g., Jones & Karston, 2008; Leonardi, 2009b; Orlikowski, 1992), we posit that computer data systems provide occasions for changes to practice, but that envisioning and habituating those practices is a social matter. In this way, agency is located in people, but also embedded in their interpretive processes and understandings about the world (e.g., O'Day, 2002; Scott & Davis, 2007; Weick, 1993). Thus, we posit that technological features and other material resources provide a starting point for what might be possible, but if certain systems or functionalities are underutilized, the larger issue may be in educators' worldview.

Implementation as an Extended Period of Adjustment

We found that central offices lost important opportunities to shape sensemaking. Although central offices sent messages about what kinds of data use were important, and although they attempted to support teachers' access to data systems, they rarely focused on their intersection. Research in other fields suggests that notions about technologies, relationships among workers, and new designs for technologies can co-evolve iteratively over time (Barley, 1990; Davidson & Chismar, 2007; Orlikowski, 1996). Leonardi (2009b) suggests that the notion

of a fixed “implementation line” fails to capture the ways in which technology implementation takes place over an extended period of social adjustment.

Our study offers a bridge between the research on technology implementation and the research on data use initiatives. Although educational scholars have begun to explore the ways in which data use can be shaped by sensemaking and central office relationships (e.g., Honig & Venkateswaran, 2012; Spillane et al., 2011), less attention has been given to the technologies that afford educators access to data. We suggest that the sensemaking perspective has practical implications for central office efforts around data systems.

First, it suggests that district leaders should treat issues around data use and data systems as conversations over time. Simply affording access to potentially beneficial or desirable system functionalities was not sufficient to ensure that teachers would use them. We found that messages from central office influenced what kinds of data were prioritized in practice. In Musial and Gibson, where the messages about data use were relatively focused, teachers focused their uses of data systems on those purposes and virtually ignored functionalities that they themselves had asked for. In Boyer, where the message was most diffuse, teachers were least engaged in leveraging their data systems. These or other messages could be considered first steps toward creating more dialogue about core issues in teaching, learning, data use, and the role of data systems.

Thus, ensuring that teachers make the most out of data systems involves not only developing teachers' knowledge about systems, but also how various functions fit into the districts' overall messages about data use. Engaging in such work also provides district leaders with opportunities to engage teachers and administrators in dialogue about what forms of data use are most congruent to their beliefs and values (Wayman, Jimerson, & Cho, 2012).

Conversations about data systems can provide an important venue not only for expanding technical knowledge, but also for reshaping what people understand about data use and what might become the district's collective vision.

Second, district leaders and technology designers can be attentive to how understandings about data and data systems are co-produced over time. This involves continually seeking out feedback from users. For example, district leaders might enact formal processes to capture innovative practices as they emerge. This involves not only attending to uses that they expected to benefit students, but also unusual or dissenting practices. Further, improved communications and relationships could help to share effective practices out to others.

Likewise, technology designers (both local and commercial) might use similar information to evolve new versions of their products. Instead of relying upon their own assumptions about how data systems fit into a district's particular context, data system developers can leverage feedback regarding what teachers are actually seeing and doing with those systems.

Third, it may benefit districts to broaden modes of communication about data systems and their use. While traditional meetings or trainings can certainly play a role in sensemaking about data and data systems, so might Web 2.0 technologies, such as self-produced online videos, wikis, blogs, and micro-blogs (i.e. Twitter). One characteristic of Web 2.0 technologies is that they encourage users to be active participants in the generation of new meaning and understandings (Greenhow, Robelia, & Hughes, 2009; Treem & Leonardi, 2012). Innovative practices, questions, and musings might be addressed and fleshed out within a larger community of like-minded colleagues. Online videos could help to store and distribute important knowledge.

Thus, communities of practice (Brown & Duguid, 1991) might be supported that could transcend the planning period, teacher's lounge, individual school, or home.

Conclusion

Although the present study has described three very different forms of data and data system use, we have been careful to maintain an air of "scholarly distance." In focusing on sensemaking and interpretive flexibility, we sought to avoid normative assertions that some systems or practices were better than others. Instead, we aimed to honor participants' unique perspectives and to tell their story. In other words, we have left unanswered the question of what is the most effective way to use a data system.

The answer that has been implied by our study is that the "most effective" use of data systems depends upon what users need at the time. Thus, in an accountability-charged context, the most effective system might be the one people are able to use to handle accountability-related goals and data. Similarly, in a context that emphasizes rigor in and pacing of curriculum, the most effective system might be the one that people are able to use for those goals. Complicating matters, what is "most effective" may change over time. Equally important, "most effective" does not necessarily address "most moral" or "most ethical" or other value-based considerations about the how and why of schooling.

While possibly complicated, understandings about the most effective and appropriate uses of a data system are not out of the hands of district leaders. Rather, our findings highlight the currency held by central offices and their priorities around data use. Messages from central office about the how and why of data use could even come to trump what teachers personally considered desirable. These findings underscore the importance of central office engaging schools in conversations and activities about how data can support teaching (Honig &

Venkateswaran, 2012; Wayman et al., 2012). Further, our findings suggest that such attention to sensemaking over time may well provide districts a strong return on their data system investments.

In the end, data systems are what people make of them. The district that brings conversations about data systems into those about the how and why of educational work will be the one that gets the most out of their data system.

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