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Building Educators' Data Literacy: Differing Perspectives

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WestEd

The use of data to inform practice in education has become an emerging field over the past decade. Beginning with an emphasis to use data for accountability and compliance purposes, a transition has occurred under Secretary of Education Arne Duncan in which data are to be used to stimulate continuous improvement (Duncan, 2009a, 2009b, 2009c, 2010a, 2010b; Easton, 2009, 2010). The U. S. Department of Education is stressing the use of data and evidence at all levels. Data-driven decision making is an expectation whereby it is no longer accepted to rely on gut feelings, anecdotes, or solely on experience. As one educator noted, “without data, you are only an opinion.”

Duncan has spoken widely about the need for educators to use data in their practice (Duncan, 2009a, 2009b, 2009c, 2010a, 2010b, 2012). He endorsed the National Council of Accreditation of Teacher Education's (NCATE) efforts to develop recommendations for the clinical practice of teaching that included a heavy emphasis on data use (Blue Ribbon Panel, 2010; Duncan, 2010b). The recommendations not stipulated that educators must be data literate, but that schools of education must also become data-driven. Most recently, Duncan (2012) challenged the schools of education to begin to help build educators' capacity to use data effectively.

Teachers and Trackers: Education is No Different From Other Disciplines

The issue of developing data literacy is complex, dynamic, and fraught with many questions. Although data-driven decision making may be relatively new to education, many other disciplines have accomplished the task of integrating data use into their training and practice. Physicians must be data-driven. They now carry technologies that enable them to analyze data at their fingertips, make diagnoses, and then determine courses of action. Businesses rely on data for sales projections, trend analyses, and purchases. Sports have relied on the collection of data and instantaneous analyses to determine when to lift a pitcher, whether to run or pass a football, or where to serve in a tennis match. In baseball and football, teams have a staff of data analysts that provide coaches with invaluable information. This was depicted in the movie, *Moneyball*. In tennis, the player makes the decisions with much tighter feedback loops between incoming data and decision points. Car mechanics must be data-driven decision makers. They accumulate data about why a vehicle may be malfunctioning. They analyze the data, forming hypotheses about the causes. They interpret the data, decide on a solution, then make a repair, and then

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monitor if their repair has solved the problem. This is a process much like what teachers do instructionally.

Data-driven decision making have a long history beyond sports and before there were formal technologies to support the collection and analysis of data as we now know it. Take for example trackers and rangers on modern safaris who use many of the same skills and processes as did their ancestors decades and centuries ago. They often use subtle and not-so-subtle data points, such as the freshness of tracks, the size of the tracks, trodden grass, broken branches, the reactions of other animals, and scat. Scat alone provides a wealth of invaluable information – the gender, age, and health of an animal, what it has eaten and how recently, and the species. Existence depends on the expertise of the trackers to collect, analyze, and interpret the data, then make decisions based on those data.

There are many similarities between teachers and trackers. Teachers collect a huge amount of data every day and must process these data to determine instructional actions. Some of the data are obvious and quantifiable, such as test scores or grades. Other data may be less obvious, such as a student's look of frustration or level of engagement, hunched shoulders, or defensive posture, but they are indicators of motivation, understanding, and attitude. Teachers are steeped in data and must be experienced in examining all sorts of data, just like trackers must be expert scatologists.

The ability to track has been passed down through generations in tribal cultures that hunt for food. Fathers model their skills and knowledge to their children. For educators, however, the path to building their capacity to use data is not so clear. Nor is it clear at what point in an educator's preparation or career should they gain this capacity (Mandinach, Gummer, & Muller, 2011; Mandinach & Gummer, 2013). Is it optimal at the pre-service level? At the graduate level? Through professional development experiences? Through on-the-job training? It is unclear if stand-alone courses or data concepts integrated into suites of courses is the preferred delivery mechanism. It also is unclear how prevalent pre-service courses are in schools of education and what is being taught in existing courses. A study is currently being conducted to better understand what schools of education are doing to build educators' capacity to use data (Mandinach & Gummer, 2012a).

On-the-job training typically occurs in two ways. Individuals in a district or school provide in-service training to their colleagues. It is unclear, however, how expert these people are or whether districts engage in trade-off behaviors, relying on the best person available who may not be an expert. The other model is training provided by professionals who specialize in professional development and data use. There are some excellent organizations that provide such training, but for many districts, the expense is a luxury they cannot afford. What the field does know is that roughly 90 percent of districts have been involved in some sort of data training for some of their staff, typically principals and building administrators (Means, Padilla, & Gallagher, 2010). Only half of the districts have provided training to its teachers on how to use data to improve instructional practice. It is unclear how extensive such training is and how broadly distributed throughout the districts. The Institute of Education Sciences (IES) Practice Guide on data-driven decision making (Hamilton, Halverson, Jackson, Mandinach, Supovitz, & Wayman, 2009) is clear that training should be ongoing, rather than an isolated event and it should be customized to the needs of the stakeholders.

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What is clear is that the field still lacks critical information about how educators learn to use data, and acquire the skills and knowledge that comprise data literacy (Mandinach & Gummer, 2012b). To data, there are more questions than answers.

Data-Driven Decision Making versus Data Literacy: A Definitional Issue

As we have noted, policy makers and researchers have been discussing data-driven decision making for a decade. According to the IES Practice Guide (Hamilton, et al., 2009), data-driven decision making is:

teachers, principals, and administrators systematically collecting and analyzing various types of data, including demographic, administrative, process, perceptual, and achievement data, to guide a range of decisions to help improve the success of students and schools. (p. 46).

But is data literacy the same construct as data literacy as data-driven decision making? If not, how does it differ? Professional development providers talk about training for data literacy (Mandinach & Gummer, 2012c; Mandinach, et al., 2011). They also admit that they do not include the transformation of data into instructional action (Mandinach, Honey, Light, & Brunner, 2008). Their training stops before that point. They teach educators how to collect, examine, analyze, and interpret data, but they do not provide them with explicit experiences to help them to translate those data into instructional or administrative action. The data are to be used to inform a decision as the above definition states, but it is the action or decision step that is not frequently sufficiently addressed. It is therefore possible for someone to be data literate but not be able to take that last step and make the data actionable, transforming the data or information into actionable knowledge and a decision. It also may be possible for someone to make decisions but not be particularly data literate. Take for example superintendents who are given distilled information from which they then make a decision. Their data collection, analysis, and interpretation skills are very different from others who may have actively engaged in a process of data inquiry. This is a fine point of discrimination, but it is important for policy, practice, and research. It is also a definitional issue.

The Special Issue

This special issue was conceptualized around a conference whose purpose was to bring together a diverse group of stakeholders and experts around data use, the objective of which was to reach a common definition of data literacy. The conference was held on May 3 and 4, 2012. It involved over 50 experts from research, policy, funding organizations, federal and state agencies, professional organizations, and professional development providers. It was clear that a common definition was a far stretch but the experts could agree on roughly 95 percent of the skills and knowledge that data literate educators need. The remaining 5 percent was uniquely identified by relatively few of the participants. The result was a working set of components that contain knowledge and skills that the experts identified as important for effective data use. These skills, in retrospect, are broader than just data literacy. They include decision making, content knowledge, inquiry, and beliefs and dispositions. The first paper, by Mandinach and Gummer, is

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a synthesis of the findings from the meeting. It reports on the data collection activities from which the knowledge and skills were identified.

The next set of papers reflect how professors and professional development providers approach the construct of data literacy. Jeff Wayman, who currently is a professor at the University of Texas, discusses data literacy in terms of the courses he teaches for administrators. His students currently hold or are candidates for principal or superintendent positions. He discusses his data in leadership courses and questions whether stand-alone or data integrated into other courses may be the most effective strategy for building the capacity to use data. Diana Nunnaley is the director of the Using Data Project at TERC. She describes the evolution of the model and how data literacy is conceptualized and facilitated in their professional development that focuses on collaborative inquiry. She provides examples of data skills and knowledge that educators acquire through Using Data.

The final paper deals with the policy implications of data literacy. Martin Orland, who facilitated the data literacy conference, discusses the policy implications of defining data literacy, using examples of other attempts to operationalize complex constructs. He questions whether a definition matters and how such a definition might impact practice around preservice and inservice training as well as research and policy.

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Defining Data Literacy: A Report on a Convening of Experts

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This article attempts to define data literacy by identifying the skills and knowledge educators need to use data effectively to inform their practice. Data literacy is an elusive construct, in part, because it may have slightly different components based on one's role in the educational system. The article examines some of the different skills and knowledge that may be needed for teachers, teacher leaders, building administrators, and others. The article concludes with a discussion of the areas where further research is needed to inform the field of data-driven decision making. This work is based on a convening of over 50 experts who provided invaluable insights into the construct.

Policy Background

Top educational policymakers have been emphasizing the importance of using data to inform teacher and administrator practice for at least a decade. The emphasis has grown substantially since 2009 when Secretary of Education Arne Duncan took office. Duncan often speaks about the importance of data use, stressing that all educators must be prepared to and use data to inform their practice (Duncan, 2009a, 2009b, 2009c, 2010a, 2010b, 2012). Duncan (2009b) has noted that, "I am a believer in the power of data to drive our decisions. Data gives us the roadmap to reform. It tells us where we are, where we need to go, and who is most at risk." Duncan continues, "Our best teachers today are using real time data in ways that would have been unimaginable just five years ago. They need to know how well their students are performing. They want to know exactly what they need to do to teach and how to teach it." For Duncan, using data is not an option. It is an imperative. Further, John Easton (2009, 2010), the Director of the Institute of Education Sciences (IES), is a firm believer that using data and data systems are the means by which continuous improvement will occur.

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It is not entirely coincidental that both Duncan and Easton have come from the Chicago Public Schools, a district that has been on the forefront of the effective use of educational data. Duncan was the chief executive officer and Easton was the executive director of the Consortium on Chicago School Research. Both saw the power of data as they tried to meet the needs of all students. They are now trying to make data and evidence a routine part of educators' work, whether in the classroom, school, district, state, or federal level.

The National Research Council (1996) notes that, "far too often, more educational data are collected and analyzed than are used to make decisions or take action" (p. 90). The phrase, data-rich, but information poor, is often invoked. Data must be actionable and have utility for educators to use them to inform practice (Mandinach & Gummer, 2012).

In parallel to the U. S. Department of Education emphasizing data use as a critical skill in education, organizations that are responsible for setting standards and policy around professional accreditation and credentialing have also begun to acknowledge the importance of data literacy. For example, the National Council of Accreditation of Teacher Education (NCATE) convened a Blue Ribbon Panel to reassess the skills and knowledge teacher candidates need to have. The outcome was a set of recommendations for what they termed "the clinical preparation" of teachers (NCATE, 2010).

The Panel states that teacher candidates, "need to have opportunities to reflect upon and think about what they do, how they make decisions, and how they 'theorize' their work, and how they integrate their content knowledge and pedagogical knowledge into what they do" (NCATE, 2010 p. 9). The report further states that teacher preparation must provide, "the opportunity to make decisions and to develop skills to analyze student needs and adjust practices using student performance data while receiving continuous monitoring and feedback from mentor" (NCATE 2010, p. 10). These are the principles of data-driven decision making and continuous improvement applied to teacher preparation and to practice.

Two of the Panel's 10 design principles relate directly to data-driven practice, or data literacy as the use of assessment. The first principle speaks to skills and knowledge teachers need to obtain.

Candidates must develop a base of knowledge, a broad range of effective teaching practices, and the ability to integrate the two to support professional decision making. To be successful teachers in challenging and changing environments, candidates must learn to use multiple assessment processes to advance learning and inform their practice with data to differentiate their teaching to match their students' progress. Further, effective teachers are innovators and problem solvers, working with colleagues constantly seeking new and different ways of teaching students who are struggling. (p. 5)

The second principle espouses the role schools of education.

Those who lead the next generation of teachers throughout their preparation and induction must themselves be effective practitioners, skilled in differentiating instruction, proficient in using assessment to monitor learning and provide feedback, persistent

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searchers for data to guide and adjust practice, and exhibitors of the skills of clinical education. (p. 6)

Even though there has been a growing emphasis on data use, states still have not fully embraced the need to require data literacy of their educators. According to the Data Quality Campaign's (2012b) most recent annual survey, only 20 states require data competency for teacher certification and licensure with five states requiring it for recertification. For principals, 24 states have requirements for certification and licensure and 7 states for recertification. For superintendents, 15 states have requirements for certification and licensure and 6 states for recertification. Twenty-seven states do not have any requirements. Twenty-five states include in their teacher education program approval process the requirement for the programs to demonstrate that they train "their candidates to analyze, interpret, and use student- and aggregate-level longitudinal data to adapt classroom, building, or district practices based on student need" (Data Quality Campaign, 2012c, p. 1).

Despite the attention and emphasis on the part of policymakers, data literacy remains an elusive construct in an emerging field. There is no question that data literacy is important for educators. Yet, the field is not quite sure what the term "data literacy" means. There is no agreed-upon definition among researchers, professional development providers, policymakers, and other relevant stakeholders. Identifying a common, operational definition is important as it can provide the foundation for research, professional development, and the pre-service preparation of educators.

Another issue has emerged that also presents some challenges to the definitional process. The field often confuses data literacy with assessment literacy (CCSSO, 2012; Greenberg & Walsh, 2012), a trend that is problematic for systematically preparing educators to use data. When data are discussed, people immediately think of assessment data to inform both classroom decisions and for accountability purposes. In fact, a report released by the Council of Chief State School Officers (2012) and written by several chiefs referred to assessment literacy as an essential skill for teacher preparation. Yet, what the authors mean is really data literacy with an assessment component. They quote the Greenberg and Walsh (2012) study that teacher preparation programs must train teachers to "use data from a variety of assessments - as well as information on student attendance, student engagement, demographics, and school climate - in order to develop or adjust instruction" (p. 2). Thus, it is clear that their intention is for educators to use more than just assessments to inform instruction yet they continue to use the term, assessment literacy. Data literacy is much more encompassing and is more accurate terminology.

As is reported here, one component of the project described in this article attempts to distinguish between data literacy and assessment literacy as an attempt to differentiate the two constructs. We firmly believe that data literacy must be considered more broadly, taking into account the widest possible range of data, not just student assessment results (Mandinach & Gummer, 2012). The data from this work supports this notion.

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Review of the Literature

Relevant Research on Data Use

The need to focus on data is not new. Nearly a decade ago, researchers at the UCLA Center for Research on Evaluation, Standards, and Student Testing (CRESST) noted:

Data-based decision making and use of data for continuous improvement are the operating concepts of the day. These new expectations, that schools monitor their efforts to enable all students to achieve, assume that school leaders and teachers are ready and able to use data to understand where students are academically and why, and to establish improvement plans that are targeted, responsive, and flexible. (Mitchell, Lee, & Herman, 2000, p. 22)

The underlying assumption around educational data use is that it will not only inform decision making but it will enhance practice; that is, the ability to use data effectively or demonstrating data literacy changes teacher practice (Chen, Heritage, & Lee, 2005; Kerr, Marsh, Ikemoto, Darilek, & Barney, 2006) and these changed practices then lead to improvement in achievement or student performance (Feldman & Tung, 2001; Schomaker & Wilson, 1995). As researchers have noted (Mandinach, 2012; Means, Padilla, & Gallagher, 2010; Wayman & Stringfield, 2006), few educators are prepared to use data effectively or exhibit data literacy. We posit that data literacy is the knowledge and skills of educators that supports their effective use of data by working individually and collectively to collect and examine outcomes, trends, performance, and other indicators based on diverse sources of data such as achievement data, formative assessment measures of student performance, students' work products, and other forms of data (e.g., demographic, affective, process, attitudes, behavioral), and to develop strategies for school and student improvement based on these data. Data use is now widely recognized as a critical strategy in the continuous improvement of classrooms, schools, and district (Duncan, 2009b; Easton, 2009; Fullan, 2000; Haycock, 2001; Johnson, 1996; Love, 2004; Schmoker, 1999; Zalles, 2005). Thus, data literacy is seen as including much more than assessment data.

To become meaningful to educators, data need to be transformed into information and ultimately into actionable knowledge (Mandinach, Honey, Light, & Brunner, 2008). Without training in data-driven processes, such as how to use and act on multiple sources of assessment and other types of data, too many educators draw only the most superficial conclusions from the data available, missing a wealth of opportunities to learn about the strengths and weaknesses of their students or educational programs. In the absence of systematic training in data literacy, educators at different levels of a school system have role-based, intuitive and often ad hoc approaches to the process (Mandinach & Honey, 2008; Marsh, Pane, & Hamilton, 2006). The role-based nature of data use is a crucial component, but without the training, that use is sometimes scattered and unsystematic. School administrators, for example, use high-stakes test data to understand *general* patterns of performance, identifying class-, grade-, and school-wide strengths and weaknesses so that they can allocate resources and plan professional development and other kinds of targeted intervention activities (e.g., after school remediation, summer school, etc.).

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Teachers tend to use multiple sources of data such as homework assignments, in-class tests, classroom performance, as well as impressionistic, anecdotal, and experiential information to shape their thinking about their students' strengths and weaknesses (Brunner, Fasca, Heinze, Honey, Light, Mandinach, & Wexler, 2005; Honey, Brunner, Light, Kim, McDermott, Heinze, Bereiter, & Mandinach, 2002; Light, Wexler, & Heinze, 2004; Mandinach, Honey, Light, Heinze, & Rivas, 2005; Mandinach, Rivas, Light, & Heinze, 2006). Thus, data literacy is exhibited differently based on educators' roles within the system. The types of learning experiences that prepare educators to use data effectively will vary based on those roles.

Data literacy must go beyond the identification and examination of relevant data, whether qualitative or quantitative, to an understanding of how to apply the data in ways that impact practice; that is, educators must understand how to translate data into actionable instructional or administrative practice (Herman & Gribbons, 2001; Mandinach & Honey, 2008; Mandinach, et al., 2006; Mason, 2002). Further, there is the need to put the right data in the hands of well-trained teachers and administrators for continuous improvement (Guidera, 2009). Despite encouragement at the policy level, there is growing consensus that schools still are not adequately prepared to create a culture of data use (Data Quality Campaign, 2012a; Herman & Gribbons, 2001; Mandinach & Honey, 2008; Olsen, 2003). If schools are going to rise to the challenge of helping all students meet academic standards, then providing high-quality training for teachers and administrators in how to use data to improve student performance is essential (Jennings, 2002; Mandinach, et al., 2006; Schafer & Lissitz, 1987; Wise, Lukin, & Roos, 1991). We must create a generation of educators who are data literate and demonstrate that literacy in their practice.

Although there is substantial research about the importance of using data, the amount of supporting research on effective data practice is scant. Reviews of literature on effective data use in the IES Practice Guide (Hamilton, Halverson, Jackson, Mandinach, Supovitz, & Wayman, 2009) found a dearth of rigorous studies on professional development programs intended to improve data use. Many studies target implementation processes and case studies about using data, rather than examining the impact of data use on performance. The IES funded Center for Data-Driven Reform in Education is examining district-level data-driven school reform, and one of their studies provides initial results on positive outcomes from data use (Carlson, Borman, & Robinson, 2011). This study was conducted at the district level so it provides little descriptive detail about the specifics of how educators are using data and the requisite skill set, focusing only on assessment data as an outcome measure. Further, Maynard (2008) and Zwick, Sklar, Wakefield, Hamilton, Norman, and Folsom (2008) note there also has been little formal research in the areas of data and assessment literacy.

A national survey provided evidence that there still is a pressing need for professional development on data use (Means, et al., 2010). Although professional development in this area exists, there is a question about the scope and sustainability of the training. As Hamilton and colleagues (2009) note, training should not be an isolated event. It must be ongoing to sustain use and impact. Similarly, as one participant in the convening on which this article is based noted, if data use is seen as an event rather than a continuous professional activity, then it is not effective data use (Mandinach & Gummer, 2012). In a follow-up study to their original survey

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work (Means, Chen, DeBarger, & Padilla, 2011) found that many teachers lack essential skills to use data effectively. The authors identified five skills: data location, data comprehension, data interpretation, instructional decision making, and question posing. Teachers struggled with question posing and aspects of data comprehension and data interpretation. Additionally, other researchers have found that teachers do not routinely think critically about the relationships between instructional practices and student outcomes (Confrey & Makar, 2005; Hammerman & Rubin, 2002; Kearns & Harvey, 2000).

Collaborative Inquiry

Also important to the understanding of data literacy is the relevance of collaboration and collaborative inquiry, whether in professional learning communities or data teams. A number of studies have examined the impact of data teams on the use of data and the acquisition of data literacy. Group decision making has been identified as an important part of the continuous improvement process (Huffman, & Kalnin, 2003; Ingram, Louis, & Schroeder, 2004). Chen and colleagues (2005) have noted that using data promotes collaboration and shared planning. Collaboration helps teachers to identify student needs (Wayman & Stringfield, 2006) and draw causal connections between teacher practices and student work (Gallimore, Ermeling, Saunders, & Goldenberg, 2009). By working together teachers jointly generate questions, analyze and present results, and determine appropriate instructional actions. When functioning effectively, they also question each others' assumptions, causing the reconsideration of ideas, generally in a productive, non-threatening, and constructive manner. Spillane and Louis (2002) have found that collaboration leads to school improvement processes, professional learning, and improving instructional capacity.

Means and colleagues (2010) examined the individual teacher data literacy as well as group data literacy and found that groups can compensate for individuals' lack of knowledge and skills. Groups are more adept at seeking clarifications, identifying errors in information and computations, considering alternative explanations, following up on questions, and using background information. Groups also exhibited more correct responses than did individual teachers as well as more engagement in working with data. In general, groups used a wider array of skills to inform decisions than did individuals.

Conceptual Frameworks

The conceptual frameworks on which much of the research on data use is based take the position that data-driven decision making is an iterative inquiry cycle. Several frameworks exist, all of which are based on inquiry cycles (Easton, 2009; Hamilton, et al., 2009; Mandinach, et al., 2008; Means, et al., 2010; National Forum for Education Statistics, 2012). Mandinach and colleagues (2008) posit that data are transformed into information and ultimately to actionable knowledge in such groups. Different skills comprise each stage of the transition from data to information and then to knowledge, after which a decision is made and outcomes determined. Subsequent iterations may be needed wherein the data user cycles back into the inquiry process. Easton (2009) notes that data are used to identify a problem, followed by the identification of possible solutions, the monitoring of progress, and the conduct of research to determine impact. This

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process is cyclical with iterations possible, and even probable. Means and colleagues (2010) include planning, implementing, assessing, analyzing data, and reflecting in their inquiry cycle. Hamilton and colleagues (2009) include collecting and interpreting data, developing hypotheses, and modifying instruction based on the hypothesis.

Mandinach and Jackson (2012) have analyzed these and other models to identify key skills and knowledge that comprise data-driven decision making. Regardless of the framework and the specific cognitive skills, it is clear that the field envisions the use of data as an iterative inquiry cycle. It is this approach that the project adopts, with the determination of specific skills identified in the work of Mandinach and Gummer (2012).

The Study

The study on which this article is based contained two key activities. The first and primary event was the convening of a meeting of diverse stakeholders and recognized experts in the field of data-driven decision making. Stakeholders represented researchers, professional development providers (both in data use and in formative assessment), funders, government representatives, policymakers, and other experts.

The conference was structured to bring these experts together for a day and a half to discuss issues around data literacy, with an expectation that a common definition of the construct might be reached. An agenda was developed to maximize open discussion, interaction, exchange of ideas, and active participation. The conference consisted of five full-group sessions. The opening session was intended to provide context and set an objective for the meeting. The two following sessions consisted of moderated panels of experts on the topics of classroom-level decision making and school- and district-level decision making. Experts were asked structured questions and a moderator probed for key responses. Following each panel, the discussion was opened to the entire group for input and reaction. The convening then disbursed into breakout groups that focused on specific topics, including (a) conditions that are precursors to data use; (b) data properties; (c) statistical/technical skills and knowledge; (d) assessment/instrument development; (e) instructional decision making; (f) programmatic decision making; and (g) data literacy and school change. These categories had emerged from an analysis of the first two sources of data for the study identified below.

Each group was asked to address specific questions. A full-group report out session followed. A second set of breakout groups was then convened, with the objective of bringing together specific stakeholders to discuss common topics. These groups included (a) funders and policymakers; (b) researchers; (c) professional development providers; and (d) other stakeholders. The final session consisted of another full group report out, followed by discussions of targeted questions. Finally each participant reported what he or she had learned and what next steps are needed to move the field along.

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Data Sources

The project consisted of four data collection components, all of which were structured to inform the definition of data literacy. First, the conference organizers examined materials in the public domain from professional development providers. Second, conference attendees were asked to provide a definition of data literacy prior to the convening. Third, participants were asked to partake in an activity designed to distinguish between data literacy and assessment literacy. Finally, the conveners examined transcripts from the meeting's sessions for key insights, issues, and recommendations to inform the emerging data literacy definition.

Results

Materials Analyses

Over 50 texts and volumes used in professional development for data-driven decision making and formative assessment were analyzed for their content and the coverage of content. Categories and codes for the content were developed based on the topics addressed in the materials. The topical areas (see Table 1) that emerged from the analysis of the materials included the following: conditions that need to be established so that a data use can be implemented (precursor conditions); inquiry process; assessment processes and practices; data sources; data quality; data use and sufficiency; data displays; analysis actions; use of statistics; inferences and interpretations; decision making; and the use of research and evidence.

The analysis provided us with the initial framework for describing what information professional development texts provide as opportunities for educators to learn about data literacy. The list is not yet exhaustive as there are sections of the texts that were not coded, so some aspects of the texts remain unexplored. However, the coding system contains the main “buckets” into which the components of data literacy as represented in these materials might be placed. An analysis was conducted of the relative frequency of each of these codes across all of the texts to begin to address the question of how deeply these constructs were addressed. Again, this analysis is tentative and descriptive rather than comparative.

We collapsed an initial set of five levels of representation indicated in the methodology section into four levels to determine whether coverage was high, medium, low, or not at all for each of the main topics and their subcodes. This analysis was conducted on 33 of the texts that most closely address professional development of educators. We then determined the maximum level of the ratings that could be assigned (high = 3, medium = 2, low = 1, and zero) and determined the relative rating of each of the texts on the topics and their subcodes. Table 1 represents the overall findings from this analysis from the perspective of the texts having at least a low level of coverage of the construct.

Almost half of the texts addressed the importance of the *school vision* while more than half discussed the need to connect a focus on data use to *other school initiatives*. Roughly half of the

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texts addressed the need to consider having the *authority* to make the changes that are indicated by the data, to understand the *change process*, to *focus on equity*, and to address issues of *school culture*. Roughly 75 percent of the texts addressed the need for *collaboration* and the requisite *characteristics of effective professional development*. Relatively few of the texts addressed the need for *cultural proficiency* in considering the use of data for decision making.

Table 1. Total Percent Present (at least a low rating) Across 33 Texts by Subcategory

Categories	Number of text with subcategory present	Percent of 33 texts with subcategory present
Precursor conditions		
School Vision	16	48%
Connection to other initiatives	20	61%
Authority	14	42%
Understand change process	17	52%
Collaboration	25	76%
Focus on equity	17	52%
Cultural proficiency	5	15%
School culture	18	55%
Characteristics of PD	23	70%
Inquiry process		
Purpose/use	27	82%
Assessment		
Types of processes	24	73%
Data		
Data access— obtaining data	22	67%
Data types	29	88%
Data quality	25	76%
Data use/sufficiency	22	67%
Data Analysis		
Data displays	17	52%
Analysis actions	25	76%
Statistics	15	45%
Inferences/interpretations	29	88%
Instructional planning		
Differentiate instruction/program	15	45%
Plan daily instruction	17	52%
Programmatic planning		
Program changes	13	39%
Understand research evidence		
Link research evidence to student performances	2	6%
Link research evidence to instructional practices	9	27%
Link research evidence to programmatic planning	5	15%

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Some form of the *inquiry process* or problem-solving cycle of using data to surface questions and address them was indicated in more than three quarters of the text. As indicated above, the texts that focused on formative assessment typically did not use this language and emphasized the use of standards or learning outcomes to generate questions that structure data use.

Roughly 75 percent of the texts addressed some aspects of the types of *assessment* that would be used to generate data for decision making. Less than 75 percent of the texts contained some references to the processes of *obtaining data*. A much larger proportion of the texts included a discussion of the *types of data* that educators need to consider and *data quality* was addressed by 75 percent of the texts. However, roughly 67 percent of the texts addressed issues of *data sufficiency*.

The different aspects of *data analysis* are addressed at various levels in the texts. Greater than half of the texts provided some information about *data displays* while greater than three quarters discussed some sort of *data analysis actions*. Issues around *statistics* were addressed by less than half of the texts. The considerations of the *inferences or interpretations* were identified in greater than three quarters of the texts.

Less than half of the texts provided much information about how educators might use data to *differentiate instruction* and roughly half addressed the use of data to *plan daily instruction*. Using data to inform *program changes* was addressed by relatively few texts. Perhaps the least well addressed constructs were those that discussed the *use of research evidence* to inform instructional practices or to make programmatic plans.

Expert Definitions

Prior to the conference, attendees submitted definitions of data literacy that were used to determine how the experts conceptualized the construct. These definitions were quite varied in terms of their characteristics. At the micro level, participants' definitions of data literacy reflected many different perspectives. At the same time, they encompassed the myriad knowledge and skills that make up data literacy. The language often differed about similar skills, making it challenging to discern if the skills are truly parallel or slightly different.

From the definitions, we constructed a Wordle, a representation of the terms used by the respondents. Figure 1 depicts the relative emphasis of the terms and phrases the experts used in their definitions. As can be seen in the Wordle, the experts used a myriad of terms in their definitions. Of course, the term 'data' was the most frequently used. Many skills were used, such as *to organize*, *to interpret*, *to integrate*, and *to analyze*. Not only were skills highlighted, but also specific topics of knowledge or understanding of topics. These included *knowledge of content areas*, *knowledge of assessment*, and *knowledge of statistics*. Interestingly, the term '*decisions*' was not prominent among the definitions. The Wordle helped us to gain an appreciation of the emphases the experts placed on different knowledge and skills, which then were transformed into the categorization of the topics. For ease of reporting here about the specific outcomes, we used four categories to discuss our analysis of the data literacy definitions.

[illegible]

Problem Focus

Data Focus

There are a host of data manipulation skills that conference participants felt were important. Once data have been collected, generated, or accessed, educators also need to know how to

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organize, summarize or synthesize, prioritize, and manipulate them before the data are analyzed. Further, educators need to understand how to troubleshoot problematic data as needed. This means diagnosing out-of-range data, inaccurate data, incomplete data, or unreliable data.

Data skills also include the ability to identify and understand patterns and trends yielded from analyses. Additionally, educators should recognize the importance of using multiple sources of data and rethink when it is necessary to acquire more data or information. Finally, educators should understand the need to drill down to more micro levels of data, such as items rather than total scores.

Process Focus

The third category of knowledge and skills relates to the processes by which data are used to inform decisions. Experts stressed the importance of collaboration to improve the use of data. This is often referred to as collaborative inquiry (Love, Stiles, Mundry, & DiRanna, 2008). At the most macro level, participants indicated that educators need to engage in an inquiry cycle as part of data-driven decision making. Moreover, this is about being able to transform data into actionable knowledge; educators must understand the sequence of steps needed, starting with generating hypotheses and being able to think critically and solve problems. They also must be able to test assumptions (either to support or refute them) and critique arguments. Educators should be able to probe for causality, linking actions to outcomes. Related to outcomes, educators need to know how to evaluate situations and impact. Correspondingly, they should understand consequences, both intended and unintended, from the outcomes.

Educators must understand how to implement decisions and make and apply interpretations from the outcomes. This means knowing how to make inferences, draw conclusions, and use the findings in their practice, often times unpacking a vast amount of information.

A final set of process skills relate to technology to support data-driven decision making. Because of the proliferation of data, the participants noted that technological tools can help educators to use data effectively. They identified the need to understand how to use data systems, tools, and applications. Correspondingly, educators also need to understand data displays and data reporting that are generated from various technologies (e.g., data warehouses, assessment systems, instructional management systems, data dashboards).

Disciplinary, Topical, Dispositional, and Other Knowledge

The fourth category consists of a collection of important skills that generally do not fall into the three other categories. This category includes disciplinary knowledge, a proclivity to use data, and knowledge of related fields. It also includes the involvement of other potential users and stakeholders.

One of the primary issues that arose in the discussion is that data literacy consists of more than knowledge of data. It must be aligned with a teacher's ability to use pedagogical content knowledge (Shulman, 1986) and transform the data into instructional action, often referred to as

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instructional decision making (Means et al., 2011) and pedagogical data literacy (Mandinach, 2012). Teachers need to know how the data can be used to inform instructional adjustments, at both the whole class and the individual student level. In parallel, there is particular administrative knowledge that must be invoked by principals, superintendents, and other leaders when making decisions.

There are a number of related skills from statistics and measurement that experts reported as part of data literacy. Yet, there is some disagreement whether educators actually need to know statistics and measurement, and if they do, which skills and how advanced the knowledge should be. Certainly educators do not need to be statisticians or psychometricians, but they do need some level of understanding of related concepts. They also need some fluency in how to develop assessments and understand the purposes of different kinds of measures. The conference participants identified the need for educators to understand basic concepts such as reliability and validity. They also need to understand the purposes and uses of different kinds of assessments.

Another composite of knowledge is more dispositional; that is, that data literacy is a habit of mind. It is a proclivity to use data. Educators should have a disposition toward data-driven decision making. They also should believe that data can be effective tools to inform their practice. Practitioners recognize that such a model is personal and deeply engrained in educators' styles of practice. These habits of mind and practice were clearly identified by the participants.

The remaining skills in this category include involving students in the data process, one of the recommendations in the IES Practice Guide (Hamilton, et al., 2009). Data literacy includes the involvement of other stakeholders such as parents, school boards, and the community. It also includes knowing how to use research findings to inform practice and to use data in an ethical manner.

Hands-On Activity

A hands-on activity was used during the conference to determine the commonalities and uniqueness between data literacy and assessment literacy, given that the professional community and other stakeholders often conflate the two constructs. Participants were provided with acetate circles that had either the term "assessment literacy" or the term "data literacy" printed on them. They were asked to construct a representation (a Venn diagram or other representation) that showed the relationship between the terms. Among the participants, we received 24 depictions that represented basically three graduated renderings. Many of the renderings were group projects. Three depictions were slightly different but were similar to one of the three models.

A first depiction (see Figure 2) indicated that there is a small amount of overlap between the constructs and a great deal of uniqueness. Five depictions (21 percent) characterized the relationship in that way. They did not provide an indication of what might be contained in the unique areas. One participant basically drew the same model but added another circle that indicated content knowledge. The individual drew the overlap between content knowledge and data literacy, but not with assessment literacy. This means that 25 percent of the participants/

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groups believe that there is some overlap between the two constructs, but the constructs also have substantial unique components.

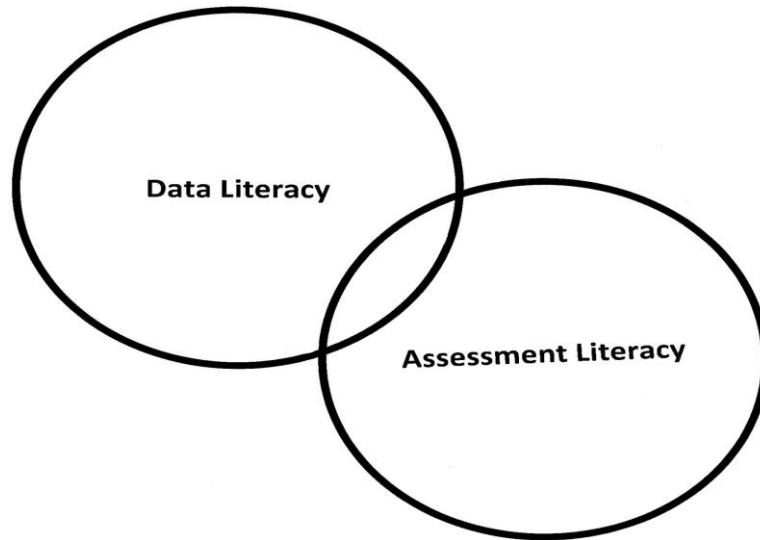


Figure 2. *Substantial Differentiation Between Data Literacy and Assessment Literacy*

A second depiction (see Figure 3) showed significant overlap between the two constructs. There is only a small sliver of unique area. Five (21 percent) of the participants/groups drew this model. One of them annotated the model by indicating that there were unique aspects to data literacy that do not contain assessment data. This individual was taking a broad view of the complete range of possible data.



Figure 3. *Slight Differentiation Between Data Literacy and Assessment Literacy*

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A final depiction (see Figure 4) was the most prevalent, with 13 (54 percent) of the participants indicating that assessment literacy is subsumed within data literacy. As a component of data literacy, the respondents used differing sizes to show how much of data literacy is assessment literacy. Some drew assessment literacy as a quarter; some as a third; and others as half of data literacy. One depiction indicated that data literacy was the foundational skill set and then used a multidimensional model, with assessment literacy growing out of data literacy as two pillars. Another participant titled assessment literacy as a specialized skill set that is part of the broader construct of data literacy.

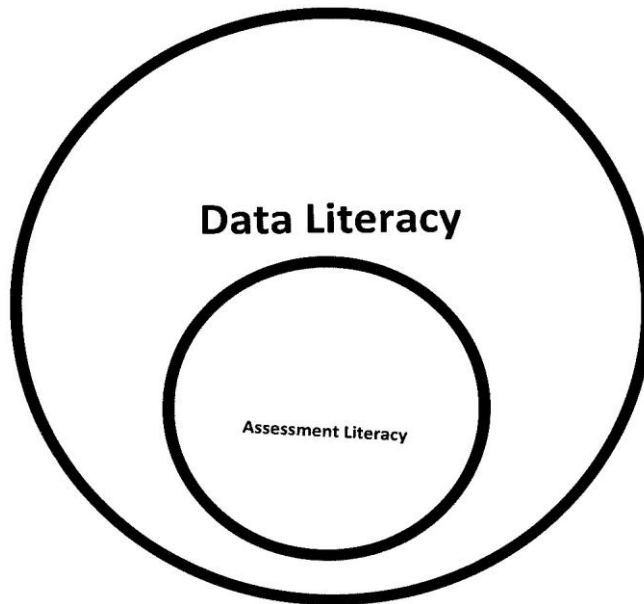


Figure 4. *Assessment Literacy Subsumed Within Data Literacy*

Transcript Analyses

The analyses of the transcripts from the conference provided additional information on a number of components to data literacy. These additions relate directly to the core of knowledge and skills that make up data literacy. They also describe the understandings about the contextual surrounds that operate in the educational environment in which data use is situated, what we have labeled precursor conditions. As indicated at the beginning of this paper, it is difficult to separate out those sets of knowledge and skills that apply directly to data literacy and those that are needed in more general contexts of the operation of education. We address each of them individually, noting issues that influence the component and its challenges. For the purposes of this article, we are only reporting on the subset of categories most relevant to teacher preparation.

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Data Literacy

The experts agreed that there is a need to provide a conceptual framework for what it means to be data literate. The conference participants indicated that a conceptual framework can help the field progress in several ways including the following:

- The development or modification of professional development models that support turning data into actionable knowledge;
- The ways in which data concepts are introduced or integrated into educator preparation courses;
- The development of a shared research agenda;
- The funding of research and development projects that are intended to inform new resources, models, tools, and data systems;
- The ways in which policymakers view data-driven decision making, thereby influencing licensure and certification practices;
- The hiring practices of educators; and
- The development of assessments and other measurement instruments based on specific competencies, skills, and knowledge that educators need to be considered data literate.

The participants also agreed that there is a continuum of data literacy that runs from novice to advanced capacity. A question remains about the necessary level of competency needed for teachers and whether that competency differs for different kinds of teachers.

Data Properties

A key theme to which the participants returned iteratively during the conference was the important role data properties play to support utility and interpretability. The data that educators are being asked to use must make sense to them. They must perceive that there is a valid and understandable rationale for the purposes for which the data are being used and for how the data are interpreted. Validity does not reside in the data or the instruments per se. Instead, validity resides in the interpretations of the data. There are crucial areas of knowledge and skills that are cogent to this aspect of data literacy.

Professional Development

Perhaps one of the most surprising findings of the conference was the lack of professional developers' familiarity with other models of training provided in the use of data in education although some have borrowed from other models. The formative assessment providers admitted that they should learn more about data and integrate data topics into their models. Conversely, the data providers can learn from the formative assessment models, in particular, how to help students use their own data. All of the participants clearly indicated that professional development is central to building human capacity to use data. They recognized that educators who have different roles in teaching and administration have different needs for professional development. They also indicated that these role-based aspects of data literacy evolve over time. This aspect of data literacy identifies a wide range of knowledge and skills about professional

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development that both educators and those who provide their professional development need to know and be able to do.

It was clear in listening to professional development providers describe their offerings that there are gaps in what is being provided. These gaps mirror the differences in professional development materials identified in the section above. The lack of focus on useful information about the technical quality of data and the crucial statistical knowledge and skills needed by educators was a concern. Professional development providers need to expand their models to incorporate training for a diversity of educators and stakeholders, not just teachers and perhaps principals. This includes superintendents, central office staff, and school board members. At the state level, there is a need to educate legislators about the data inquiry process. Parents and students also should learn how to interpret data.

Gaps also exist in terms of what is provided to educators during their pre-service and subsequent formal training experiences. Institutions of higher education can benefit from the experiences of the professional development providers as they consider developing courses on data-driven decision making or integrating data concepts into teacher and administrator courses. Moreover, the field needs to consider how to scale professional development because many schools and districts cannot afford the providers' full-blown models, and therefore must rely on internal mechanisms for training their staff. For schools and districts that have engaged the professional development providers, a major issue around sustainability occurs. Questions arose such as how districts subsequently take ownership for the sustainability of data use once the training is concluded. This is a systemic problem.

Another topic that affects professional development is determining when during an educator's professional practice to introduce data literacy to educators. This relates to the developmental continuum from pre-service, to novice, to experienced educator. One expert posited that educators should enter the profession as a "tabula rasa" and become trained on the job. Others indicated that educators should experience opportunities to develop data literacy throughout their professional preparation. The implications for professional development are unclear.

Schools of Education and Institutions of Higher Education

Participants recognized the role that schools of education have in building educators' capacity to use data. The relationship between what professional development providers do and what institutions of higher education can support are not clear. Identifying the appropriate early experiences for future teachers and administrators will help clarify those roles, as well as determining how to embed educators' continuing education experiences into the data terrain of schools and districts.

Communication

Messaging around the use of data is essential. Participants agreed that the use of data in education currently has a negative connotation, frequently being connected to the identification of failing systems and teacher evaluation to identify sub-par teachers. Participants agreed that

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improving understanding of how and why data inform continuous improvement needs to be the focus of the message, rather than punitive or accountability purposes. Data use must be seen as an effective tool for educators.

The field must strive toward a common language for data literacy. Participants noted that even within the field, there are different interpretations and different language used by different factions. For example, the sort of language that the technology experts use about the data systems and data-driven decision making more generally will not be readily understood by practitioners or some policymakers. Working toward a common language is essential for the field to communicate with diverse stakeholder groups. To that end, the Data Quality Campaign (2013) has convened a group of stakeholders as a task force to try to establish common language that will help facilitate a better understanding of data literacy.

Conclusions

Data-driven decision making is here to stay. It is not a passing fad, as many educators may have expected. Assumed, or wished based on other educational fads. It is no longer acceptable for educators to rely simply on gut feelings or anecdotes. Educators must be armed with data and evidence on which to base decisions. Learning to use data is an ongoing process of professional growth and exploration. As one educator said, “Without data, you are only an opinion.” Data can no longer be considered a four-letter word. Data must become a tool to benefit educators’ practice and educators must be trained in how to use data effectively to inform their practice. Policymakers cannot expect educators to acquire data literacy by osmosis. It takes time, sustained training, and experience to become data literate. Data use is no longer an elective; it is a requirement of the field. Given this new reality, we must consider how the field leverages change so that all educators become data literate. We recognize the complexity of the challenge, but the benefits of data literacy to bring education more strongly into an evidence-based practice far outweigh the obstacles.

The intent of this work was to develop an operational definition of data literacy that we could use to inform the professional development, research, and funding decisions needed to improve how educators use data. The participants in this study indicated that they reached roughly 95 percent agreement in a definition while they differed in some remaining elusive elements based on the remaining 5 percent uniqueness. In the end, we find ourselves agreeing with Francis Crick, who writes about the research agenda needed to support the development of a scientific explanation of consciousness.

What I have tried to do here is to sketch the general nature of consciousness and to make some tentative suggestions about how to study it experimentally. I am proposing a particular research strategy, not a fully developed theory. What I want to know is exactly what is going on in my brain when I see something.

Some readers will find this approach disappointing since, as a matter of tactics, it deliberately leaves out many aspects of consciousness they would love to hear

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discussed—in particular, how one should define it. You do not win battles by debating exactly what is meant by the word *battle*. You need to have good troops, good weapons, a good strategy, and then hit the enemy hard. The same applies to solving a difficult scientific problem. (Crick, 1995, p.xi)

The conference yielded a wealth of information, not just about defining data literacy, but also about the landscape in which data use exists. It is impossible to separate what it means to be data literate from that landscape because of the complexities and the systemic nature of the use of data in education. The field will continue to explore what it means to be data literate and further explicate its implications for teacher preparation both at the in-service and pre-service levels.

In fact, since the time of the convening and the analyses of the data sources, we have begun to further refine the categories, gain a better understanding of the requisite skills and knowledge, develop a refined conceptual framework, and even define the construct of data literacy based on different educational roles. For example, we have termed teachers' use of data literacy for instruction as *data literacy knowledge for teaching*. We are reconsidering how the composite of skills and knowledge combine to form the construct of data literacy. We also are exploring the idea that data literacy may be a component of data-driven decision making and that other skills and knowledge must be part of the construct. Our work will continue to explore what it means for educators to use data effectively in their practice.

What we have identified in this paper is what we hope is a useful conceptual framework through the further refinement of the needed skills and knowledge for data literacy.

We will continue to pursue this line of research while the Data Quality Campaign's task force on data literacy attempts to reach out to professional organizations and other stakeholder groups to try and brand data literacy in terms that will resonate and be broadly understood by diverse audiences. Our goal is to provide the objective research foundation on which the Data Quality Campaign and others can ground their advocacy to establish the importance of data use and data literacy in education venues.

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Leading Data Use: Pre-Service Courses for Principals and Superintendents

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Introduction

In 2002, Earl and Katz noted that data use was no longer a choice for school leaders, but was a must. Now, over 10 years later, research continues to describe difficulties in everyday educational data use and the struggles that leaders have in fostering these environments (Anderson, Leithwood, & Strauss, 2010; Wayman, Cho, Jimerson, & Spikes, 2012; Young, 2006).

One proposed solution to these problems is pre-service graduate courses that teach future leaders the skills they will need to create effective data-using cultures (Mandinach, 2012). For years, I have taught two such courses: one to future principals and one to future superintendents. In this article, I will describe these two courses and the thinking that underlies them.

Effective Data Use

It is important to first describe what I mean by *data* and *data use*. For the purposes of this article, *data* is any information that helps educators know more about their students. Examples include state achievement tests, interim or benchmark assessments, locally-developed periodic assessments, tests, quizzes, disciplinary information, parental information, and teacher observations. *Data use* comprises the activities in which educators engage as they collect, organize, analyze, and draw meaning from these data to inform practice. Additionally, I use the term *effective data use* to distinguish between data use practices that benefit educators in their practice from other data use practices that have been shown to actually hinder educational work (Valli & Buese, 2007; Wayman, Snodgrass Rangel, Jimerson, & Cho, 2010; Young, 2006).

The effective use of student data has been shown to provide a variety of benefits to educational practice. For instance, collaboration has been shown to be richer and more productive when centered on data (Datnow, Park, & Wohlstetter, 2007; Lachat & Smith, 2005; Wayman & Stringfield, 2006). Or, goals and visioning have been shown to be especially well-defined when based on data (Datnow et al., 2007; Halverson, Prichett, Grigg, & Thomas, 2005; Young, 2006).

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On the other hand, research has demonstrated negative outcomes from ineffective uses of data. For instance, ill-defined data initiatives can deprive educators of valuable time (Ingram, Louis, & Schroeder, 2004; Wayman et al., 2010; Valli & Buese, 2007). Or, frustration with computer systems and other supports can foster negative attitudes toward data initiatives and leaders who implement such initiatives (Anderson et al., 2010; Wayman, Cho, & Shaw, 2009; Young, 2006).

In describing both the benefits and hardships of effectively using data, research is clear that leadership plays a critical role (Anderson et al., 2010; Knapp, Swinnerton, Copland, & Monpas-Huber, 2006; Wayman & Stringfield, 2006). That is, leaders at the district and school levels often have great influence over how data are used – and thus, whether that use is successful. It is this basic perspective that I use in my courses. In the following section, I will describe more fully the perspectives that drive how I have developed these courses.

Perspectives Underlying Pre-service Leadership Courses.

In delivering my principal and superintendent courses, I am guided by some underlying beliefs and choices about how data should be used. These courses are only 15 weeks long, so there must be hard choices on what to include and what to leave out. I am not arguing that mine are the “right” lenses from which to view leadership for data use. I write this section merely to offer delimitations and give the reader a context from which to understand the rest of the article.

First is the belief that data should be used by educators in the course of everyday work. Research describes instances where job-embedded data use is associated with more involvement throughout an organization (Datnow et al., 2007; Lachat & Smith, 2005; Wayman & Stringfield, 2006); further, I have learned over multiple research projects that teachers seem to maintain momentum when data use is conducted within their everyday work.

Second, my courses focus on data use for teaching and learning. Data use for other educational functions (e.g., bus schedules, finance, human resources) is also important, but skills in those areas are more easily gained through other courses than are skills for using data to inform teaching and learning.

Third, my courses focus on leadership for using data and focus very little on actual data manipulation. In early iterations of my courses, we focused part of the work on manipulating data. I forged agreements with data system vendors and with local districts to provide real-time data sets, allowing students to manipulate these data and learn cutting-edge data systems. In time, I phased out these components of my class for a number of reasons: For one, I learned that while my students found these skills beneficial, they were also able to gain these skills outside of my class through published resources (e.g., Bernhardt, 2009; Boudett, City, & Murnane, 2005; Bracey, 2006; Love, 2002) and work-related professional development. They had much less access to critical leadership skills such as strategies for leading entire faculties in using data and ways of setting up district-wide structures to support data use. Another reason was that research consistently described successful leaders using leadership skills (Datnow et al., 2007; Lachat & Smith, 2005; Wayman & Stringfield, 2006; Young, 2006). A final reason was that my students let me know they found these data exercises boring. They have shown much more interest in the

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leadership aspect. To be clear, data skills are critical for leaders to possess. But students can get these skills in many different places, while pre-service leadership skills are harder to come by.

Finally, I believe that educator judgment is one of a school's most precious resources. Thus, I teach that data do not replace educator judgment. Instead, data inform and enhance educator judgment.

These principles underlie the content I choose and experiences I try to extend to my students. In the next two sections, I will describe my courses for future principals and future superintendents.

Data-Informed Decision-Making for Future Principals

Students in the principal course are typically practitioners working in schools as teachers, instructional support staff, or possibly in administrative roles. They are seeking a principal licensure and a Master's degree in administration. Class sizes typically range from 15 to 20 students.

Research suggests that principals in many contexts have difficulty leading faculties in using data. There is research that describes principals successfully leading faculties (Datnow et al., 2007; Copland, 2003; Wayman & Stringfield, 2006), but these studies were all conducted in contexts chosen for their aptitude in using data. Research in contexts not chosen for their aptitude in using data paints a different picture. In these studies, principals have been shown infrequently using effective leadership strategies, or in some cases, even using harmful strategies (e.g., Anderson et al., 2010; Wayman, Cho, & Johnston, 2007; Wayman, Lehr, Spring, & Lemke, 2012; Wayman et al., 2010; Valli & Buese, 2007; Young, 2006). Further evidence of principal need is gained from studies that describe hardships for teachers that could be alleviated by effective principal leadership for using data (Anderson et al., 2010; Wayman et al., 2009; Young, 2006).

Thus, I have concluded that it is important to offer pre-service principal candidates instruction in leading their faculties for data use. In the following two sections, I describe the content that future principals receive in my course and the experiences through which they get it.

Content

In reading others' research and conducting my own, I concluded that principals' problems in leading for data use were often because they did not implement a variety of strategies shown by research to facilitate school-wide data use. With my research team, I identified a list of 12 such strategies that could be employed (Wayman, Lehr et al., 2012).

Over the last two years, I have centered my course on these strategies. Because of time constraints, we examine only nine of the 12 strategies. They are:

1. Focusing data use on a broad context
2. Fostering common understandings

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3. Facilitating collaboration around data
4. Goal-setting
5. Asking the right questions of data
6. Structuring time to use data
7. Distributing leadership
8. Ensuring adequate data-related professional learning
9. Data system support

We spend the early part of the course examining research that generally describes components of effective data use (e.g., collaboration, proper technology). Once these are established, we spend one week on each of the above strategies while revisiting components studied earlier in the course. As the course wraps up, we work to identify ways these strategies can fit together.

The strategies are ordered so more complex ones come later. For instance, distributing leadership is difficult to implement without common understandings and common goals. Or, data system support can be more easily worked into the fabric of teacher work when collaboration is functioning well and data use is focused on a broad set of data.

Experiences

Course content is centered on assigned readings. While these readings are aimed at practical issues, most are academic readings from journals, reports, and book chapters. These choices reflect my belief that principals should be good consumers of the latest research. Readings are targeted each week to a particular strategy. Students are expected to connect the readings across weeks – and thus, connect their knowledge of specific strategies.

Class discussions are important to student learning. Input into these discussions is well-rounded and multifaceted: students make points based on their interpretation of the reading and their own experience, and I have a set of points to make about the reading and the chosen strategy. Further, we draw from the experience of principals by way of student interviews. Each week, one group of students is assigned to interview their principal about that week's strategy (typically three times during the semester), learning how the principal perceives this strategy. Portions of the whole-class discussion are designed to query the interview group about what they found from their principals. This multifaceted discussion format has worked well because it offers them a chance to gain varied perspectives on the content while casting it within their own experiential reality.

Graded products for this class involve the construction of a "toolkit" for their strategies. Each week, students are required to fill out a form for the focused strategy; on this form, they highlight reading content that was particularly meaningful to them, notes on their principal interview (or

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notes on others' interviews, if the student was not interviewing that week), and their own reflections on the strategy. As the semester progresses, students are expected to amend and edit these forms based on connections they make with other strategies. At the end of the semester, students turn in a final "toolkit" that is fully usable beyond this course.

A variety of other experiences have been used to help students understand this content. Each semester, one or two commercial vendors are invited to do demonstrations and answer student questions. At the end of the semester, three or four principals from who are particularly proficient in leading for data use form a "principal panel" that fields student questions and engages in discussion. Other guest speakers are sometimes used throughout the semester based on their expertise in particular strategies.

Data-Informed Decision Making for Future Superintendents

Students in the superintendent course are typically practitioners working in schools as principals, central office administrators, or possibly teachers. They are seeking a superintendent certificate and an Ed.D. in administration. Class sizes typically range from 10 to 20 students.

Much of the knowledge base on effective data use has been provided by studies that focused on specific aspects of the district, such as teachers, principals, or technology (e.g., Anderson et al., 2010; Honig, 2012; Marsh, McCombs, & Martorell, 2010; Wayman & Stringfield, 2006). In addition, some scholars are examining how these aspects fit together organizationally (e.g., Halverson et al., 2005; Mandinach, Honey, Light, & Brunner 2008; Spillane, 2012; Supovitz, 2010; Wayman et al., 2007; Wayman, Jimerson, & Cho, 2012). By positing that data use is a district-wide enterprise, this research is examining the various structures, supports, and processes that can help data be used effectively throughout the district.

In line with this body of research, the course for future superintendents is taught from an organizational perspective called The Data-Informed District (Wayman, 2010; Wayman et al., 2007; Wayman, Cho et al., 2012). In the Data-Informed District, uses of data are characterized by integration, collaboration, and effective support. In the following two sections, I describe the content that future superintendents receive in my course and the experiences through which they get it.

Content

To create a Data-Informed District, students need to know how to create effective structures and processes. However, it is difficult to create such supports for teaching and learning if students do not understand how data use operates in classrooms and schools. Accordingly, I first teach content into on building-level data use, followed by content on district supports.

The unit on building-focused data use helps students understand data use throughout a school. It includes examination of the formative process (Black & Wiliam, 1998; Popham, 2008) as a basis for using data throughout the school. The unit also includes material on teacher practice in using

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data (Lachat & Smith, 2005; Wayman & Stringfield, 2006) and principal leadership (Copland, 2003; Knapp et al., 2006; Wayman et al., 2012).

Once students understand effective building-level data use, they are ready to consider how structures and processes can be provided. For instance, students learn the importance of establishing common understandings for data use, along with processes to guide these (Datnow et al., 2007; Wayman, Jimerson et al., 2012). They learn the various roles that central office personnel may serve in supporting data use at both the building and district level (Honig, 2012). Other topics are also taught, such as effective professional learning supports (Jimerson & Wayman, 2012; Wayman, Jimerson et al., 2012) and technology supports (Means, Padilla, & Gallagher., 2010; Cho & Wayman, forthcoming). Also important is learning about the difficulties and mistakes that leaders can encounter in implementing data initiatives (Wayman et al., 2009; Valli & Buese, 2007).

Experiences

In learning these skills, students engage in a number of experiences designed to help them connect course content to practical issues. Course content is delivered primarily through whole-class discussions. These discussions consist of very little instructor lecture; rather, content is built through discussions based on assigned reading. Discussion is typically divided into two parts: the first part consists solely of connecting the assigned reading to the topic at hand and to prior reading. In the second part of discussion, students are asked to view course content critically through their own experience.

Since this course is part of a doctoral program, students are expected to learn research writing. Accordingly, the graded products in this course consist of written papers. In these papers, students choose a data-related situation within their current context and examine it through the lens of our readings and course discussion. For example, one student recently examined a data initiative she had attempted to implement as a principal. Another student had recently been put in charge of professional learning in her district and chose to examine how our course content could guide her in providing effective data-related professional learning opportunities.

Over the years, many other experiences have helped students learn in support of course discussions and written papers. For instance, guest speakers have included individuals from the U.S. Department of Education, education policy organizations, and professors from other universities, to name a few. Data system vendors are sometimes invited to do software demonstrations and answer student questions. Students have engaged in qualitative analyses of research projects to gain insight into data-related activities in other contexts. Also, many students have found useful a full-day symposium I call “Expert Day,” where students engage in activities with data use experts from school districts and commercial data system vendors.

Conclusion and Future Directions

The two courses described here seem to hold value for students. These courses fare well on end-of-semester evaluations and students report anecdotally that these courses provide them skills they may not have acquired otherwise. Still, there are improvements that can be made to pre-

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service leadership preparation; in concluding this manuscript, I will briefly describe some thoughts for improving delivery of this information.

University courses typically involve the equivalent of 40 – 50 class hours. This is not much, when considering the wide range of skills necessary to lead effectively for data use. Accordingly, there are many issues in my class that I would cover if there were more time. For instance, I wish I had time to cover material about the psychometric properties of various types of data. Also, there are numerous policy issues that principals and superintendents must deal with. While we discuss issues such as No Child Left Behind, common core standards, and teacher effectiveness, I wish there were time in my course to address these fully.

I also note that much of what is taught in my courses could fall under the heading, “just good leadership.” Years of research on leadership and organizations has shown that practices like exploring common understandings, promoting collaboration, codifying processes, and effectively using technology are effective, regardless of whether they are applied to promote data use (e.g., Argyris & Schon, 1996; Hallinger & Heck, 1996; Leithwood & Jantzi, 2006; Louis et al., 2010; Senge, 2006). In fact, many of these topics are addressed in leadership courses in many universities.

In talking to colleagues nationwide, I have learned that, when leadership for data use is part of the pre-service leadership curriculum, it is typically delivered as a stand-alone course such as those described here. However, effective data use is commonly shown to occur not as a *separate* event, but *in the course of* the usual workday of educators (Datnow et al., 2007; Lachat & Smith, 2005; Honig, 2012; Wayman & Stringfield, 2006). Thus, it seems that the act of teaching a stand-alone course on data use is misaligned to the actual work of effective data use. That is, if we promote data use as embedded within educator work, why is learning about data use not embedded throughout the pre-service leadership curriculum?

Perhaps the solution to these problems is to embed data use throughout the pre-service leadership curriculum of both principals and superintendents. I envision a course during the first semester of coursework that addresses major points of the properties of data and the workings of effective data use in schools. Going forward, data use would be a component of every course, in nearly every topic. In some cases, it would be worked into existing material. For instance, when principals are taught leadership skills for faculty collaboration, the issue of using data in collaboration would be included. In other cases, it would be worked in as a new element in an existing course. For instance, when superintendents were taught about school improvement, time would be dedicated to reviewing the appropriate use of assessment data for this purpose.

Certainly, embedding data use into all facets of pre-service leadership training would be a large undertaking in many universities, possibly involving restructuring classes and curriculum, and providing new training for professors. However, as Friedman (2005) pointed out, our world is different now than it was in the previous century. Technology and rapid information flow have caused permanent changes. Earl and Katz (2002) were right so long ago when they said data use is now a must for leaders. The question now is, will our leaders be prepared for it?

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Professional Development to Build Data Literacy: The View from a Professional Development Provider

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Tools or Culture Changing Process

Advocates for data-driven-decision making typically assume that the primary resource needed to use data effectively to inform practice is access to data. More specifically, policymakers' focus on data-driven-decision making has not included the necessary steps which include provisions for high-quality, sustained professional development required to introduce and support a major cultural shift in how schools make decisions (Duncan, 2009). While it is understood that access to data is critical for data analysis to take place, a countervailing assumption is that everyone in a school system already has the requisite knowledge and skill sets to analyze the data and take action based on the findings.

With increased accountability, American schools and those who work in them are being asked to do something new—to engage in systematic, continuous improvement in the quality of the educational experience of students and to subject themselves to the discipline of measuring their success by the metric of students' academic performance. Most people who currently work in public schools weren't hired to do this work, nor have they been adequately prepared to do it either by their professional education or by their prior experience in schools. (Elmore, 2002; p. 5)

While Elmore clearly describes the practice of continuous improvement as “something new” and something few educators have been prepared to do, his statement does not offer a hint of the tectonic shift in the culture of school practice that is required to achieve “systematic, continuous improvement in the quality of educational practice”.

Early educational data focused on compliance. Collection and reporting of data about students, budgets, and resource allocation were collected in response to state or federal program requirements for primarily accountability purposes (Mandinach & Jackson, 2012; Spellings, 2005). When the first pioneers in the use of data to inform decisions closer to classroom practice, educators made data analysis possible by creating simple spreadsheets or database applications to collect and display useful data sets. The technological industry has since responded by creating powerful data warehouses, reporting systems, and other technology-based applications. These tools have ever-increasing sophistication for merging multiple sets of data to be displayed in a teacher's desktop dashboard – screens linked to the data warehouse which can be organized to display data for a class for a single assessment or a series of assessments for a period of time.

Additionally, American Recovery and Reinvestment Act (AARA) grants have been made available to 41 states and the District of Columbia to supplement support to develop longitudinal data tools. A few states have released proposal requirements for professional developers to

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submit plans for designing and providing basic training in how to use the tools. But such cursory training fails to take a comprehensive perspective on data use and implementation because it is more focused on training educators specifically to use the technological tool rather than the data. It stops far short of what educators really need to use data effectively in their practice. Less well acknowledged and appreciated are the necessary components required to move an entire school, as a system, to understanding and using their data to inform day-to-day changes in pedagogy or other means of enhancing learning opportunities; that is, that schools need professional development opportunities to support a culture of data use (Love, Stiles, Mundry, & DiRanna, 2008). These infrastructure issues are central to the need to provide quality training and preparation for educators to use data.

The Data Quality Campaign (DQC) and the American Productivity & Quality Center (APQC) studied 69 school districts and identified the best practices in data-driven decision making (Sanchez, Kline, & Laird, 2009). The study found that, “Best-practice districts use professional development as an opportunity to establish and promote a culture in which data are used to inform instruction and guide collaboration versus a culture in which data are used to evaluate performance” (p. 4). The study highlighted that these districts offer twice as much data-related professional development for new teachers and 50 percent more for returning teachers than do other districts. Further, the professional development needed to be focused on processes for making meaning of the data rather than the technology. Contributors to the study were quick to point out that the analysis of data was greatly enhanced when the teachers learned and adopted a structured process for analyzing their data.

The need for a deeper learning experience to support the use of data began to emerge in the late 1990s when TERC’s Regional Alliance for Mathematics and Science Education (Eisenhower Consortia member for the Northeast and Islands) began organizing professional development to support standards-based instruction in mathematics and science in New England. Alliance staff were frequently asked for assistance with analyzing data. Superintendents, principals, and directors of curriculum were at a loss about where to begin. Who should analyze the data? Which data? When? And how? Scant resources around the use of data in educational settings, particularly at the classroom level, were available. TERC’s *Using Data* program began its development as a response to the requests coming from the field and was later funded by the National Science Foundation to develop the *Data Coach’s Guide* (Love et al., 2008), a task-organized resource for teachers’ analyzing data.

At the time, TERC’s *Using Data Project* began to respond to requests and needs in the field to help educators develop skills to analyze and use their data. The focus of the work was to create a process and tools for data use and enculturation. The process became known as “Collaborative Inquiry”. The tools became a set of resources to support Collaborative Inquiry for the *Using Data Project* entails the analysis of data by teams of teachers working together to create meaning from the quantitative and qualitative data and to examine the implications of those data for decision making. The process was agnostic to the source of the data (e.g., data warehouse, assessment system, or classroom work), the style of the reports, or the content learning being analyzed. The professional development engagement focused on the analysis of data by classroom teachers. It was designed to support a transformative experience or culture shift in

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how decisions were made in schools. The term “data literacy” was embedded in a much larger culture of practices.

After a three-year period of developing and field-testing every component of the process, a five-phase progression for improving student learning was completed. The five phases represent a continuum for organizing for collaborative inquiry. The fluid foundation of the continuum is based on analyzing and comparing multiple measures of student learning results to identify specific student learning problems followed by using research and data to verify root causes of student learning gaps. The routine interrogation of research to assist in identifying and verifying root causes adds to teachers’ knowledge enabling them to design solutions representing actionable steps to be implemented that address the causes (see Figure 1). Continuous monitoring of impact provides the on-going focus to student learning and subsequent adjustments to instruction.

In the simplest terms, this progression provided a structure for analyzing multiple forms of data with the goal of identifying a student learning problem, followed by using research and other local data to verify causes of the student learning problem. The last step provides the means for teachers to generate solutions – actions focused on eliminating the underlying causes of learning gaps with a plan for monitoring the impact of changes in instruction.

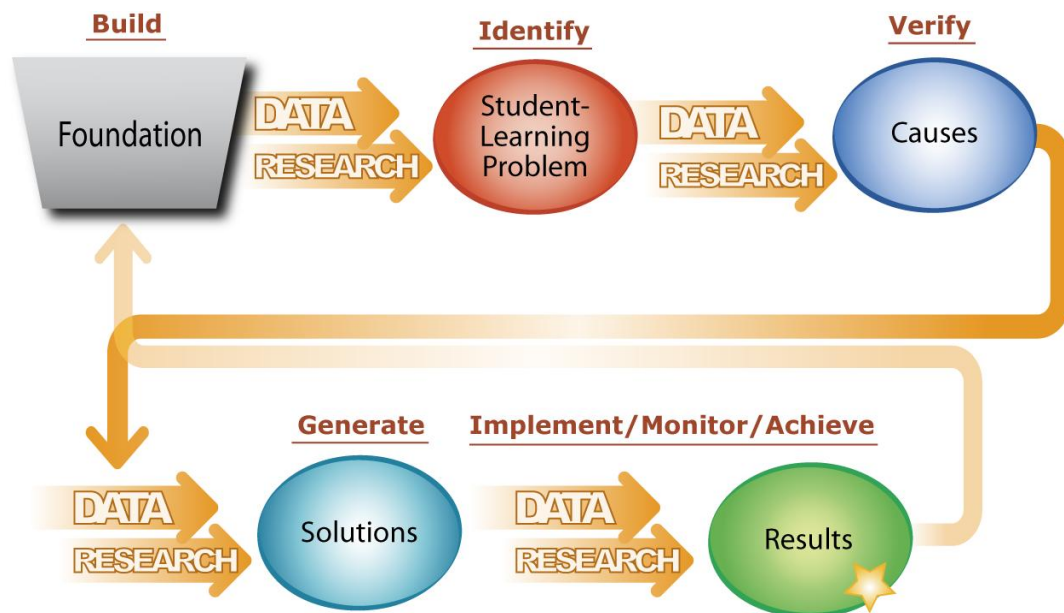


Figure 1. *Using Data's Five-Phase Progression*

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The process has continued to evolve as state and local data systems have proliferated in schools and districts while accountability requirements have steepened. At the same time, *Using Data* continues to sharply focus on building the human capacity to work with peers, to develop confidence in the ability to analyze data in ways that produce desired results, and most importantly, to question assumptions long held about the origins of poor student achievement. Experience gained during 12 years of working closely with teams of teachers has shown how data analysis can provide a catalyst for transforming schools into real learning communities where the quest to answer questions enables teachers to solve the problems.

Data Literacy – More Than a Skill

In doing the work of teaching teachers how to engage with their data, recurring themes surface. At its core, teachers' data literacy is really a complex, three-dimensional intersection of factors. Data literacy is more than the individual skills of teachers; it is a test of the "system". The question becomes: What does it take to initiate, support, and sustain a process of continuous improvement that is informed by the ongoing analysis of data (Means, Padilla, & Gallagher, 2010).

The complexity was brought into stark relief when experts trained in the *Using Data Process* who work with practitioners to help them acquire the skills and knowledge to examine their data, began to work with researchers (Mandinach, Lash, & Nunnaley, 2009). The researchers pushed the training experts to describe the outcomes of the *Using Data* professional development in terms of the skills, knowledge, and beliefs of teachers who can use their data effectively – not discrete skills reflecting the individual's level of expertise, but a highly intricate system of jointly orchestrated abilities.

For professional developers, the frustration comes when factors external to the professional development flow of work marginalize the impact of the work to the extent that the capacity of teachers to implement new practices is reduced to safe, traditional responses and potentially skew the measurement of impact. It's more than Michael Fullan's "implementation dip"; it is an implementation catastrophe (Fullan, 2009).

Take for example a circumstance that is not atypical, such as the changes in policy regarding the use of early release afternoons. Principals will often take advantage of early release days to schedule time for grade level teams to analyze benchmark assessments, or for vertical content teams to compare the findings of recent analyses by grade level teams. This is often prime time for the entire faculty to review findings across content and grade levels and to reflect on implications needing attention throughout the school. When schools receive assignments from the central office for faculty groups to meet to learn about RtI, Common Core, or inclusion practices, it comes at the expense of in-depth data analysis that provides a better context for these or other topics taken in isolation from a school's data. Researchers work to identify what to measure to determine where changes in behaviors are occurring or not occurring. The challenge is made more difficult by the need to further identify the positive or negative impacts of systemic and contextual influences that can support or negate the changes in individual and team-based skills, attitudes, and beliefs.

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To gain an understanding about the depth of data use skills among staff in a school or across the district, *the Using Data Project* often uses a rubric (see Figure 1) to measure what we consider to be low and high capacity data use. This rubric gives the *Data Facilitators* (the trainers) a very good picture of current practice and indicators about where the gaps may be or where practice is essentially surface level data analysis and not substantively connected to changes in practice. For practitioners themselves, it can be their first introduction into what effective data use entails.

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District:		School:
Low-Capacity Data Use		High-Capacity Data Use
1. Misinterprets and misunderstands data	<hr/> 1 2 3 4 5 6	1. Accurately interprets data and discerns what they mean
2. Uses aggregated and disaggregated data only	<hr/> 1 2 3 4 5 6	2. Regularly uses item-level data and student work
3. Accepts achievement gaps as inevitable	<hr/> 1 2 3 4 5 6	3. Responds to achievement gaps with immediate concern and corrective action
4. Uses single measures to draw conclusions	<hr/> 1 2 3 4 5 6	4. Uses multiple sources of data before drawing conclusions
5. Uses only summative measures	<hr/> 1 2 3 4 5 6	5. Uses formative and summative measures
6. Blames students and external causes for failure	<hr/> 1 2 3 4 5 6	6. Looks for causes for failure that are within educators' control
7. Draws conclusions without verifying hypotheses with data	<hr/> 1 2 3 4 5 6	7. Uses student work and data about practice and research to verify hypotheses
8. Fails to monitor implementation and results; big surprises at the end	<hr/> 1 2 3 4 5 6	8. Regularly monitors implementation and student learning; no surprises
9. Responds as individual administrators and teachers	<hr/> 1 2 3 4 5 6	9. Responds in teams and as a system
10. Prepares for tests by drilling students on test items	<hr/> 1 2 3 4 5 6	10. Aligns curriculum with standards and assessments; implements research-based improvements in curriculum, instruction, and assessment
11. Tutors only those students just missing the cutoff for proficiency—"bubble kids"	<hr/> 1 2 3 4 5 6	11. Differentiates instruction; provides extra help and enrichment for all who need it
12. Tracks students into classes by perceived ability	<hr/> 1 2 3 4 5 6	12. Increases the rigor of the curriculum for all students; assigns the best teachers to those who need them most
13. Chooses strategies based on instinct or the latest educational fad	<hr/> 1 2 3 4 5 6	13. Chooses strategies that are culturally proficient and research-based and have a logical link to the intended outcome

Figure 2. *Data Capacity Rubric: Low- and High-Capacity Data Use Continuum*

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Unpacking the Learning

Moving educators from the low to the high capacity indicators of the continuum is the work of the professional developer, as well as district and building leaders. Deconstructing each indicator into the specific beliefs, knowledge, and skills that are intrinsic and represent a significant shift in beliefs and practice is required in order to build the set of experiences necessary to progress toward the high capacity end of the continuum. For researchers the task becomes building an understanding of the deconstructed elements in order to design instruments, observations, and data to measure the presence or absence of the essential beliefs, knowledge, and skills, elements in the professional development experience and the support systems that are related to changes in practice.

The following list represents a partial set of the beliefs, skills, and knowledge we have identified as being crucial to effective data-driven decision making, based on our years of experience in delivering professional development in data use. We have learned these elements are prevalent when a district or schools is on track to enculturating the successful use of data:

- District and school leaders understand how to communicate, demonstrate, and support a vision for the use of data;
- District and building administrators have the knowledge and skills to introduce and support teachers' use of data;
- District and building leaders deeply understand the amount of time it might take for teachers to reach a high capacity level of data use and are prepared to allocate the time and resources needed to support a transformative experience;
- Teacher leaders and teachers have access to the data, including aggregate levels of reporting (i.e., all 4th grade students' literacy results; all algebra 1 classes); disaggregate (i.e., relevant subgroups), content strands (i.e., in math—algebraic thinking, number sense, geometry, measurement, data analysis, probability and statistics), and item results indicating the percent of students who selected each distractor as well as the percent correct. (For the latter level of analysis to be productive, the items themselves must be released.);
- Administrators and teachers understand the subtle differences in what can be learned from different types of data (i.e., state criterion referenced assessments, benchmark assessments, formative assessments, common assessments, student work) and how to use them together to understand gaps in student learning;
- Teacher leaders, instructional specialists, and teachers are able to design needed reports in the data system;
- Building leaders and teachers are comfortable with a shared leadership structure in the building for making decisions and acting on them;
- Teachers believe their students are capable of learning at higher levels and that changes made by teachers are the keys to enabling that learning;
- The quality of the data is high and teachers can get explanations and answers to questions about the quality of any data point;
- Assessments are turned into results quickly and available for analysis;
- Administrators work with teachers to create time for teachers to meet regularly by: integrating data analysis into all decision making activity; freeing up teachers to meet in

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common blocks; and using release time and faculty meeting for teachers to work in vertical teams, reporting and reflecting on their findings;

- Teachers use a structured process for analyzing data that helps to illuminate previously held assumptions about student learning;
- Teachers routinely interrogate relevant research to shed light on the student learning problems they have identified;
- Teachers analysis of data and research is followed by time to co-develop new approaches to teaching the content;
- Teachers are continuously deepening their knowledge of the content;
- Teachers are continuously deepening and adding to their pedagogical content knowledge;
- Teachers have a deep understanding of what constitutes different levels of rigor in a given content domain;
- District and building leaders understand that after the initial professional development, as new practices are implemented and refined, an implementation dip can occur; and

All leaders and staff understand that analysis of data is not activity in and of itself but the skills form the foundation of all decision-making pathways in a school (i.e., school improvement plans, Response to Intervention (RtI) process, classroom or content teacher consultation with specialists, teacher mentoring and coaching, professional development planning).

The elements above are complicated and difficult to envision in practice in isolation from the school and district contexts. Take for example, ongoing work we are currently doing in a large urban district that relates to the fourth bullet and, highlights the “house of cards” and fragility that exists in systems. The schools’ data teams used regularly scheduled common planning times to analyze interim assessments administered in the Fall, Winter, and Spring periods. Changes in district leadership brought a change in the benchmark assessments provided by the district after the first assessments were administered at the beginning of the school year. The replacement instrument reported proficiency only by strand and was an older instrument not aligned to Common Core Standards. To form a deeper understanding of the particular concepts and skills students where students struggled, buildings needed to scramble to identify or develop common assessment items to administer to enable the analysis of student work.

In many of the schools deeper analysis of the data was further compromised by inflexible district policies regarding the re-assignment of math coaches based on student enrollments. Teams with a math coach who had the deeper content knowledge and could often see relationships in the data that teachers were just beginning to realize were moved to different schools or the position was eliminated.

Therein lies the conundrum faced by professional developers in planning the engagement, researchers in attempting to analyze the interplay of the elements, practitioners in anticipating the work to be accomplished, and policymakers in establishing the mechanisms for supporting the work.

Acquiring the Skills

How to engage teachers in a set of exercises and skills designed to gradually introduce new skills, practice them, reflect on their implications in the local context, and do the planning steps

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needed to integrate and implement the practices locally requires a deep knowledge of the elements required in the professional development itself. It also requires the ability to respond to the local context with enough experience to correctly predict where contextual factors are likely to impede the progress of teachers and how to deal with the circumstances.

The contextual factors often include prevailing beliefs about what is involved in effective analysis of data. States, districts, and regional technical assistance providers often create professional development request for proposals (RFPs) on assumptions such as that:

- Being able to “read” the data report results in decision making leading to more effective practices in the classroom;
- The quality of the interpretation of data is a function of sophisticated “data reporting” systems;
- An afternoon in-service, or a full release day at most, will give teachers the skills needed;
- Having participated in data analysis professional development, teachers will be able to implement skills into their daily routines;
- Teachers can find the time during the regular school day to rigorously analyze their data and take action on the results;
- All assessments are equally valuable in providing needed feedback on student learning;
- All teachers believe that all kids can learn; and
- Administrators know how to support teachers’ use of data and administrators can learn anything else they need to know via a 60-minute webinar.

To illuminate one way these myths are revealed, one only has to read the ARRA RFP and the responses from any of the states developing Student Longitudinal Data Systems. The RFP might require the provider to deliver professional development for 80,000 teachers in a single day. This stipulation is both unrealistic and inadequate.

Data Provides the Catalyst to the Deep Learning

When professional developers bring data to the table as part of a learning activity, the data are the object of the activity. Teachers use a structured process to analyze the data. The process enables teachers to distance themselves from the data, separating their observations from their inferences. The data become another entity in the room, almost another personality and this one with the power to raise questions, challenge assumptions, and demand more. Teachers find some of their most fundamental beliefs being challenged and the data begin to surface questions leading to new understandings. The transformation that begins to occur reveals that the answers aren’t in the data. The answers come from the team assembled around the table.

An Example

Recently a grade 4 team analyzed their latest state assessment results, and then compared them to the first district benchmark assessment. Their data coach was able to prepare reports that included all of the classes in each grade level. The teachers are only able to see their own class and therefore have no way to compare how all students in the grade are performing. Working as a “data team” requires that teachers are able to create or given access to reports that combine all

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of the results for a grade level. The report for the benchmark assessment provides information by quartile in terms of a predictive factor (i.e., 0 to 25% indicates low possibility that these students will be proficient on the next year's state assessment). When teachers saw that only 3% of their students were in this lowest range, they were perplexed. They were equally stunned to see that 30% of their students were in the 25% to 50% range. They wanted to see more data to help them understand. When shown the cut off scores and the number of students at each cut off score, they began to get a clearer picture of where students were in their performance and they observed that a large number of their students had, in fact, scored high enough to be in the next range but just barely. Instead of being discouraged, the teachers felt invested and energized. They felt the data had given them a way to focus. By seeing the entire grade's performance, individual teachers no longer felt that "all of the lowest kids" are in my class. They were able to observe similar patterns across the grade. This in itself was helpful to begin talking about the implications of what they were learning.

Once the analysis of data has highlighted a specific set of concepts or skills that are challenging to students, the search for the "why" ensues and teachers use a process to identify causes related to gaps in student understand. The process includes finding research about student learning which frequently leads to further analysis of local data to determine degree of alignment to practices described in the research or to answer other critical questions about local contexts. A natural consequence of identifying causes is teachers seeing the need to have meetings with their colleagues who teach at the levels prior to and following their grade (vertical articulation). It leads teachers to view the standards as more than a discrete grade level skill but a series of progressions. And now they want to understand the progressions. The question about alignment of the taught curriculum comes up in various ways. Frequently through the causal analysis process teachers begin to wrestle with what constitutes "rigor" and questions about being consistently rigorous across the curriculum and vertically throughout the grade levels arise.

Other questions include... Are we using the same language in the content areas? This highlights the point that for many teachers, professional development and professional activities are viewed as separate, distinct silos of work. We "unpack" the Common Core. We "map" the curriculum. We "RtI" our kids, meaning that we group students by level of intervention needed. "We went to DOK (Depth of Knowledge) training". Through the process of analyzing their students' results and being allowed to ask and seek the answers to questions about what they are seeing, teachers become "self-conscious and systematic learners" (Liebman, 2012, p. 29). And when the entire building is composed of multiple teams of teachers consistently digging into their results, the school begins to function quite differently. Liebman (2012) captures it this way. "Institutional-learning approaches make teachers and principals into self-conscious, collaborative innovators who can steadily help children accelerate their learning, by tailoring improvement strategies to each student, educator, and school, then carefully monitoring results and adjusting interventions based on what does and does not work" (p. 29). This is a vastly different culture compared to the "silo" approach to learning that occurs now. Data analysis when carried out by teams of teachers working collaboratively has potential to accomplish much more than "data training".

The elements noted above have implications for every aspect of how professional developers design their materials, for how funders allocate the dollars, and what expectations are articulated when professional development in data analysis is planned. The most damaging results of

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superficial and uninformed knowledge about what it requires to support teachers and administrators in the process of learning to use data effectively are poorly conceived solicitations around funding that fail to speak to the prevailing contextual factors that under estimate the need for high quality, professional development, that provide insufficient budgets to initiate and support standards-based professional development, and that take a “tack this on” mentality. Perhaps this issue also indicates a shallow understanding of what “data literacy” actually is as well as a failure to recognize the enormous potential data use by teachers – going well-beyond “data driven decision making”.

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Why Definitions Matter: Data Literacy and Education Policy Change

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To paraphrase a famous observation from Daniel Patrick Moynihan (as cited in Weisman, 2010), there are two fundamental truths regarding the role policy can play in having educators rely more on data to guide their decisions. The first is that this goal will only be realized when the culture in our educational institutions truly changes to embrace this concept. The second is that the right policies can catalyze these necessary cultural changes in classrooms, schools, and administrative offices.⁴

The U.S. Department of Education has spent over 600 million dollars in grants to state education agencies (SEAs) in recent years to upgrade their data systems so that decision makers can have higher quality data such as longitudinal student records linked to individual teachers as well as to pre and post K-12 school experiences (NCES, 2013). This emphasis has also been manifest in the criteria for state Race to the Top awards (U.S. Department of Education, 2010). At the classroom level, the federal government has supported the creation of “next generation assessment systems” which includes formative assessment data linked to new standards as a centerpiece of the new models from the two federally supported assessment development consortia (Tamayo, 2010). These are unprecedented and significant initiatives with much promise. However, even the most ardent supporters of these policies are not likely to argue that they are sufficient in and of themselves to change the culture of educational decision making so that educators place a greater premium on data. And without such a change, such investments will not fulfill their promise.

What are the chief impediments to creating a much stronger education data culture at all levels of the educational enterprise? The most fundamental is developing a clear definition and common understandings in the field about what is actually meant by the term “data literacy” and how we expect “data literate” educators to act. This is not just a needed technical exercise but also reflects an important and essential step in the evolution of effective policy in this area.

While the need to more precisely define the concept of data literacy may appear so obvious as to be trite, the education policy landscape is littered with vague, multiple, and conflicting definitions of policy concepts and objectives. Take for example the case of accountability. Think of the different ways the term “accountability” has been defined and operationalized by education policymakers and advocates as one prominent example of policy definition

⁴ Moynihan actually referred to two central liberal and conservative truths: “The central conservative truth is that it is culture, not politics, that determines the success of a society. The central liberal truth is that politics can change a culture and save it from itself.”

amorphousness. To some it means holding teachers and administrators responsible for the educational outcomes of their students as measured chiefly by standardized test scores (Greenberg & Walsh, 2012). To others it means holding educational systems to a clearly defined standard for providing the resources and supports needed for students to succeed at school as measured by both test scores and other indicators of student well-being (Broader Bolder Approach to Education, 2009). And to still others it means maximizing the responsiveness of the educational system to the desires of its parents as reflected in their freedom to choose the educational experiences their children will receive. Proponents of each of these policies use the term “accountability” as a prominent rationale for their advocacy, but they obviously mean very different things when they use the term. One can argue that the rhetorical popularity and embrace of the term by virtually all actors in the public policymaking process has cheapened its substantive value as a meaningful and useful construct in educational policy reform.

At an early stage in the evolution of a particular policy it may make eminent sense among policy entrepreneurs to keep their definitions “fuzzy”. This is because as long as a rhetorically popular goal is vaguely defined it can be embraced by diverse constituencies, each providing an interpretation of its meaning and implications benefitting the interests of its respective group. Such vagueness is thus often helpful in fostering the coalition building needed to bring a policy issue to the forefront of the policy agenda (Delori & Zittoun, 2009).

However having vague, multiple, and conflicting definitions of an important educational objective becomes much more problematic if and when it morphs from a set of relatively inchoate desires to a set of specific policy actions governed by legislation, regulations, and/or implementation activities designed to change the behaviors of educational decision makers and alter the culture of our educational institutions. At this stage in the policymaking process it is essential to clarify critical definitions and constructs so that resulting policy enactments can be clearly seen as representing a reasonable “theory of action” to achieve the particular objectives sought. Otherwise, precisely because of the broad rhetorical appeal of the concept, policies in its name can very easily become detached and distorted from the original goals of its advocates. This in turn will lead to at best “symbolic policymaking” which is devoid of substantive content or, at worst, policies which – rhetoric notwithstanding -- may actually make it less likely to achieve original policy goals.

Two prominent recent examples where leadership in developing clear operational definitions and resulting theories of action have helped drive educational policy reforms are in the areas of standard-setting and research. In the former, while rhetoric about the importance of setting more transparent standards for student learning was long commonplace in educational improvement and reform circles, it was only beginning in the 1990s after the development of specific clearly defined common standards around “what all students should know and be able to do” that policies around student learning expectations began to become integral to education reform agendas (Danek, Calbert, & Chubin, 2004). States began to define and set standards in some content areas, informed by experts who identified expectations for learning and performance. This process was a driving force for education policy reform. Since then, the development, implementation, and refinement of student content and performance standards has continued as a cornerstone of the education reform landscape, as reflected most recently in preparation for implementation of “common core” standards and aligned new assessment systems over the next

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few years in nearly every state (Enright, 2013). The standards movement has truly been “a reform with legs,” but it has been grounded in the need for operational definitions.

Similarly, educational reformers and entrepreneurs were for years citing their initiatives as “evidence-based” or “research based” without any clear criteria for justifying these designations. While such appellations helped promote these initiatives’ credibility, the absence of any commonly agreed-upon definitions around what constitutes adequate “evidence” or “research” to justify a claim of effectiveness led to their promiscuousness and irrelevance as a guide to policymakers. This circumstance has begun to change since the congress defined what constitutes “scientifically-based research” with the 2001 No Child Left Behind Act and the 2002 Educational Sciences Reform Act creating the Institute of Education Sciences (IES) (Zucker, 2004). Such definitions have shaped the policies of the IES as well as other agencies supporting educational research which in turn has altered the work of education researchers (to be more consistent with the definitions) and allowed policymakers to be more critical consumers of research claims.

In both of the above examples, developing clear operational definitions of standards and research/evidence in education were not ends in themselves, but rather a means for penetrating educational policy by creating a focus and foundation around which supportive and aligned policies could then be constructed. These policies in turn helped alter the behaviors of those in the system and change the culture of relevant educational institutions. It’s important to note that the clarifying definitions were not pleasing to all. Some fissures among the initially supportive coalitions around standards and research/evidence-based reforms became evident as the definitions and resulting implications for policy action inevitably pleased certain interests while disappointing others. This may appear unfortunate, but in fact is a sign that the initiative is reaching a more mature stage in the policy cycle with real potential to influence change.

Data literacy is at the precipice of this stage. Many policymakers are aware of the concept and it enjoys broad rhetorical support. But to begin to change educational policy and through that the culture of educational decision making requires a clearer definition that can ground a theory of change and action agenda. Advocates must take on the tough work of defining what data literacy is and is not, and to use these definitions as a basis for driving system change. And it must be prepared to perhaps lose some supporters in this process who may not be comfortable with the resulting definitions and new policies which build on them.

There are at least three areas in which more common and accepted understandings of what it means to be data literate can become an important catalyst for educational change: in preservice teacher and leader preparation programs, inservice professional development, and research and evaluation. While virtually every actor in our educational system is now being inundated with unprecedented amounts of data as a result of both federal investments and technological breakthroughs, their effective use in addressing educational problems depends on these actors’ ability to understand, interpret, and act on such data wisely. This requires that “data literacy” be transformed from its current status in policy circles as a desirable but relatively abstract concept to a discrete set of knowledge and skills expected from both current and newly minted teachers, building administrators, and district personnel.

Such knowledge and skills should be specific to the expected demands in using data that are relevant to the positions in question. Mandinach and Gummer (this issue) provide a path toward a global definition of data literacy, but acknowledge that the application of this definition is role-based and based on the level and types of use. What it means to be “data literate” for teachers should differ by content area because the nature of the data they will be expected to interpret and act upon will necessarily differ. Data derived from state assessment systems for example will be particularly relevant to teachers of English/Language Arts and Math, while teachers in other subject areas will be expected to rely more heavily on local assessments linked to specific benchmarks such as those embodied in Student Learning Objectives methodologies (Reform Support Network, n.d.). Building administrators and district officials need to be able to interpret and act upon more aggregate level data coming not only from student assessments, but also from other data that are increasingly becoming available and potentially actionable in real time such as on attainment, coursetaking, school climate, teacher performance, and the demographic/background characteristics of both teachers and students.

Defining with specificity what data literacy implies for particular teaching and administrative positions is critical for driving curricula offerings and certification/licensure requirements for new teachers and administrators. Even more importantly in the short run, it will also help define and standardize the nature of professional development experiences in this area for those now in the system. Current educator preservice training experiences by-and-large predated the explosion of potentially actionable data to inform their decision making. As such, their ability to use such data appropriately and effectively is heavily dependent on the quality of their professional development training and its relationship to the demands and data specific to their positions. However, a review of the inventory of professional development resources currently available in this area reveals major inconsistencies in how data literacy is defined as well as frequent ambiguity in aligning training to particular educator roles in the system (Mandinach & Gummer, 2012; U.S. Department of Education, 2010). Mandinach and Gummer (2012) reviewed nearly 50 books on how to use data with few, if any, formal and explicit definitions of data literacy. In fact, the only way to extract a definition was through an implicit process of identifying essential knowledge and skills and then inferring what the authors meant by data literacy. Even the convened experts whose goal was to define data literacy, could not agree up to a certain point on a definition (Mandinach & Gummer, this issue). The result is that, while there may well be effective and appropriate professional development programs that build data literacy among its participants, their incoherence when taken as a whole strongly suggest that it is not having the kind of cumulative impact on the profession that would be possible if the field had more common definitions, expectations, and objectives for these offerings.

Would increasing levels of data literacy among different participants in the educational enterprise actually change their behaviors in interpreting and acting on data? If so, would these changed behaviors positively affect important educational outcomes? If so, what aspects of data literacy are most important to foster desired behavioral changes and what types of training are most effective in affecting such changes? These are all critical policy-relevant questions that can potentially have a major influence on how policymakers perceive and invest in reforms designed to enhance data literacy. But it's difficult to imagine a coherent research agenda addressing them without clearer and more consistent understandings around what it means to be data literate. Researchers require this so that they can engage constructively with one another and build on

each other's contributions. Again the current condition is muddled, with some researchers defining data literacy as synonymous with assessment literacy (Mandinach & Gummer, 2012), and investigators applying their own idiosyncratic constructs to the term which inhibits the potential to aggregate findings across studies to address the most salient questions of policymakers. More consistent definitions of data literacy that are cognizant of policymaker needs and expectations is a needed first step in developing a knowledge base that can over time play a significant role informing and improving policy in this area.

I have argued here that the concept of data literacy in education has limited potential to advance the policy objectives of its proponents without much greater clarity in definition that takes into account specific expectations of the knowledge and skills needed for different positions in the system. Such a change -- which would potentially lead to tangible significant benefits in advancing teacher education reforms, the quality of inservice professional development, and research/evaluation agendas -- is needed to move the concept from its current "comfort zone" where it enjoys broad rhetorical support and interesting pockets of activity to a more central place in educational reform agendas. It would inevitably mean adjustments and dislocations among those whose concept of the term and its applications are not reified through the resulting definitional clarity, and will require leadership, forbearance, and risk taking among adherents. Is the field ready and able to make this leap? Recent activities suggest that it is coming to grips with the problem and beginning to address it.

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The NORMES Mission

The establishment of the National Office for Research, Measurement and Evaluation Systems (NORMES) addresses the immediate need for improved student assessment and evaluation practices in school systems. NORMES uses interactive technology to identify best educational practices and curriculum interventions that contribute to increased student achievement. NORMES provides an improved system for early detection of those students at-risk academically and the specific information necessary for educators to respond. NORMES transcends geographical obstacles in bringing educational resources to academically distressed and/or isolated school systems.

Goal

The goal of NORMES is to extend the current best practices model of a student centered assessment system developed at the National Office of Research, Measurement and Evaluation (NORMES) for use in a national center for schools.

The NORMES office at the University of Arkansas created a student-centered system of collecting and reporting student data distributed via the internet to school systems in Arkansas. This system, the Educational Data Delivery System (EDDS), includes both public access and restricted access sites for reporting of educational data.

Recognitions

The EDDS system was recognized in 2001 by the U.S. Department of Education and the Council of Chief State School Officers as a model program for collection and dissemination of educational data. The system is routinely updated, with current upgrades including individualized on-line data assessment features and No Child Left Behind reports for principals and administrators. The NORMES website and public data for Arkansas are available for review at <http://normes.uark.edu>.

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