Involving Teachers in Data-Driven Decision Making: Using Computer Data Systems to Support Teacher Inquiry and Reflection

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Accountability mandates such as No Child Left Behind (NCLB) have drawn attention to the practical use of student data for school improvement. Nevertheless, schools may struggle with these mandates because student data are often stored in forms that are difficult to access, manipulate, and interpret. Such access barriers additionally preclude the use of data at the classroom level to inform and impact instruction. Fortunately, there are newly available computer technologies that allow efficient organization and access to student data. In addition to allowing easier accountability reporting, these tools allow user-friendly data access at all educational levels, meaning that teachers can use these tools to engage in the informed reflection necessary to improve classroom practice. In this article, I discuss teacher use of these systems, providing insight into the function of these tools and discussing conditions that make these tools of the most service to teachers.

The use of data to inform educational decisions has recently drawn increased attention, spurred largely by accountability requirements set forth at the state and federal levels. A familiar example is the 2002 No Child Left Behind (NCLB) legislation, which mandates a significant increase in the gathering, aggregation, and upward reporting of student-level data. NCLB policy carries an implicit assumption that the availability of data will inform and initiate changes in teaching practice, but mechanisms for helping educators turn accountability data into actionable in-

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formation are lacking in NCLB. Thus, although the NCLB legislation has provided much-needed stimulus for the gathering and presentation of student data at the school and district levels, it remains necessary to move beyond reporting mandates to provide teachers with the access and support needed to use these data in improving instruction.

State educational agencies, school districts, and other educational entities have collected and stored large amounts of student data for years. Despite this abundance, the employment of data to inform and improve educational practice has been the exception rather than the rule. In previous work, my colleagues and I have argued that one major barrier to the use of student data has been technical (Wayman, Stringfield, & Yakimowski, 2004): Although schools have been "data rich" for years, they were also "information poor" because the vast amounts of available data they had were often stored in ways that were inaccessible to most practitioners. Recently emerging technology is changing these circumstances. Computer tools have arrived on the market that provide fast, efficient organization and delivery of data. They also offer user-friendly interfaces that allow data analysis and presentation by all users, regardless of technological experience.

The new availability of these data systems not only helps expedite NCLB reporting at the school and district levels, but these systems also offer an additional, important feature. With classroom access to these tools, school systems have the opportunity to allow every teacher to have access to previously unattainable data describing their students. These data can be turned into information to improve classroom practice. Accompanied by the proper preparation and support, these tools provide schools with the efficient access necessary to reach beyond the basic requirements of NCLB and engage all educators in the rich application of student data to everyday classroom practice.

The data access provided by this technology is a necessary condition for informed inquiry into educational practice, but such access is not sufficient on its own. The mere presence of data does not automatically imply that usable information is available; educators need support to use these data to the fullest extent. Because the availability of these systems is relatively new, a large knowledge base describing best practices in applying these systems in the service of education does not yet exist. In this article, I provide a piece to this puzzle by describing conditions that best support the use of one form of these tools—data-warehousing and presentation systems.

SCHOOL DATA USE

The use of data to inform school practice may seem new because of the increased attention brought about by NCLB, but this concept has received varied attention in school research literature for more than 30 years. Many studies of positive outlier,

"effective" schools demonstrating unusual gains in academic measures have shown that the thoughtful use of student data positively correlates with a range of measures of student achievement (e.g., Edmonds, 1979; Stringfield, 1994; Teddlie & Reynolds, 2000; Weber, 1971). Research on school improvement and school effectiveness has suggested that data use is central to the school improvement process (Chrispeels, 1992; Earl & Katz, 2002), and there are case studies available describing ways in which data has supported educational decisions (e.g., Feldman & Tung, 2001; Lachat, 2002; Pardini, 2000; Protheroe, 2001, Symonds, 2003).

Streifer (2002) listed exploring group differences, examining growth over time, program evaluation, and identifying root causes of educational problems as several ways data can be used. Chrispeels, Brown, and Castillo (2000) demonstrated that data use can be a strong predictor of the efficacy of school improvement teams: Data use not only increased efficacy directly but also served as a mediator for the positive effect of other factors. Chrispeels et al. described a longitudinal case study of a leadership team that saw the research role of this team evolve to be one of prominence over the 4 years of the study. Chrispeels and colleagues noted this as an empowering process: The more the team learned about and used data, the more data informed important decisions.

Case studies and interviews have suggested that data use may have a positive effect on the people involved in the educational process. Feldman and Tung (2001) observed that schools involved in data use often evolved toward a more professional culture. Educators in their study became more collaborative during the data/decision process, and school business consequently became less "privatized." Similarly, Nichols and Singer (2000) reported increased interdepartmental collaboration. One high school teacher in this study said, "We saw a total picture versus just our own department" (p. 36). Symonds (2003) presented a variety of data indicating that teachers involved in data inquiry were more collaborative. Earl and Katz (2002) noted that school leaders involved in data use often consider themselves in charge of their own destiny, increasingly able to find and use information to inform their school's improvement. Armstrong and Anthes (2001) and Massell (2001) found that data use was helpful in improving educator attitudes toward educational practice and students. Administrators in Massell's study viewed data use as stimulating a search for new ideas; data opportunities encouraged many to seek more professional development. Massell also found that increased communication and knowledge provided by data appeared to be positively altering educator attitudes toward the school capabilities of some underperforming groups. Armstrong and Anthes found the introduction of data use resulted in heightened teacher expectations of at-risk students, noting positive changes in teacher attitudes regarding the potential success of previously low-performing students.

Although accountability policies do not stress teacher involvement in data-based decision making, researchers such as Black and Wiliam (1998) have argued for a classroom-focused policy because of the access teachers have to

students and their performance. Preliminary evidence suggests that, although they are often critical of accountability initiatives, teachers will embrace such policy when it is soundly implemented and responds to the learning needs of their students. Data presented by Ingram, Louis, and Schroeder (2004) and Massell (2001) showed that although teachers expressed concerns about the appropriateness of and importance assigned to assessments, they also recognized the new information afforded by assessments, along with the stimulus for new ideas brought about by inquiry. In short, research suggests that teachers are in favor of solutions that help improve the education of the children they teach.

We can paint a pleasant picture of the benefits of using data to inform school practice, but this picture must be moderated by findings from Stringfield, Reynolds, and Schaffer (2001): Many schools have found the thoughtful analysis of data to entail a great deal of labor, as data are often stored in ways that frustrate flexible analyses. In examining data use and observing schools, my colleagues and I have found this situation to be the rule rather than the exception. A positive response to this problem lies in the application of advanced computer technology to efficiently organize, store, and produce data for educator use (Wayman et al., 2004). The advent of educational data analysis tools represents a new opportunity to provide access to large amounts of student information that will facilitate more informed decision making and improve school performance. Such access should not be limited to administrative personnel: Teachers should also be involved. In the following section, we provide an introduction to data warehousing and reporting tools for this purpose.

AN INTRODUCTION TO DATA-WAREHOUSING AND PRESENTATION TOOLS

A burgeoning number of computer systems are being marketed for the purpose of efficiently delivering student data to educators, and these systems provide many different functions. Unfortunately, no system provides comprehensive access to solutions to educational problems, so districts must choose between many types of data systems. Common types of systems include (a) student information systems (SIS) that provide real-time accounting of daily school function (e.g., attendance, schedules) but are typically not designed to provide analysis or access to data beyond the current school year, (b) assessment systems that rapidly organize and analyze frequent benchmark assessments but are typically not designed to provide access to such data over time, and (c) data-warehousing systems that provide access to historic data of all types but are typically not designed for immediate turnaround of new data.

The types of functions available in today's computer systems are nearly mutually exclusive; that is, it is uncommon to find one type of system that incorporates

the functionalities of another type of system. These lines are blurring; it is likely that technology will one day advance to the point where one system can perform all functions. Until then, school personnel need to choose the type of system that best fits their needs.

Although many types of data systems are useful for schools, I have chosen to focus on data-warehousing and presentation tools in this article. These systems offer unprecedented access to a wide range of historic data, with the capacity to retrieve a student's entire history for one analysis. Further, these tools provide user-friendly presentation interfaces that can provide data in an efficient, easily understood format and greatly reduce the amount of software training needed to use the system.

In education, the term *data warehousing* is often used to refer to the collection and organization of all data into one electronic repository. Data warehousing integrates data that are often stored in disconnected areas (e.g., student discipline data or achievement test data), thus allowing examination of relationships across a variety of domains. Although the concept may sound simple, organizing large, disparate databases into one common store is a complex task. Recent technological gains have resulted in tools and models that efficiently warehouse data for the examination of relationships commonly explored in the education arena. Data warehouse and presentation systems can be built using local talent or can be purchased commercially.

The data-warehousing process begins with an inventory of available data (if a district has contracted with a commercial vendor to implement a data system, the vendor usually offers help with the data inventory). After data identification is completed, school and/or vendor personnel begin the task of populating the data warehouse, often from a variety of locations and data systems (e.g., a student information system, Excel spreadsheets, paper records). Data warehouses serve as a common store of data but usually do not replace a school's other electronic data systems, such as the SIS. School personnel typically continue to maintain these systems for daily management and upload information from these systems into the data warehouse on a regular basis.

Once the data are available, user-friendly data presentation interfaces may be launched. These interfaces connect the user to the database and are the intermediaries through which users may examine relationships within the data. These systems typically offer the user two types of data access: preformatted reports or query tools.

Preformatted reports are previously compiled summaries of data that are available for viewing or printing with one click and require no specifications, alterations, or input from the user. For instance, a teacher might click on a link to view a report on students' achievement test scores, broken down by ethnicity and gender. Query tools allow ad hoc data specification, permitting the user to browse data or create customized reports. For instance, a teacher might use a query tool to explore achievement test histories of the students in a particular

class, compose summaries of these histories based on desired groups, or simply browse available data.

In addition to unprecedented data access, these systems promise the ease of use that facilitates examination of student histories and learning tendencies. The data presentation interfaces offered by most commercial vendors are easy to learn and use, employing familiar Web-form elements such as check boxes and pull-down menus. Through these user-friendly systems, data are accessible to all educators of all levels of technical expertise. Most users who can check the weather or shop on the Internet can easily learn how to access student data using these interfaces.

COMMERCIALLY AVAILABLE DATA-WAREHOUSING AND PRESENTATION SOFTWARE

Many school districts have built their own data-warehousing and presentation systems for internal use. In addition, there are many commercially available systems for this purpose. Wayman et al. (2004) noted that because of specialization and efficiency, competent commercial vendors can usually get a system running in much less time than it would take to locally develop a system. In terms of both time and monetary costs, commercial systems may prove to be cheaper in the long term.

Should district personnel opt to buy a data-warehousing and presentation system, there are many commercially available systems from which to choose. Wayman et al. (2004) provided a report on data systems that offer access to existing student data. Along with issues surrounding implementation of such a system, this report also provided reviews of 13 software systems the authors identified as providing teacher-friendly access to student data. Updates to these reviews, along with other updated research on educational data-based decision making, are available at http://www.csos.jhu.edu/datause.

Commercially available programs for analyzing student data share several features that a school should expect when purchasing software for student-data management. For instance, most commercially available programs are Web-based and thus offer user access from any Internet connection. Additionally, these programs offer the capacity to produce reports based on the disaggregations mandated by the NCLB legislation, and all offer some form of ongoing technical support. Presently, however, there is no single system available that provides a full slate of features. Each system has strengths and weaknesses, so district personnel should take care to evaluate properly each system in terms of current and future needs.

Although the power and availability of these systems is exciting, their mere presence is probably not sufficient to fully support educators in turning data into actionable information. Unfortunately, little research has been conducted that examines best practices in encouraging widespread teacher use of these systems. In the follow-

ing section, I offer three important areas that should be considered in providing support for the use of these tools.

SUPPORTING TEACHER USE
OF STUDENT DATA SYSTEMS

Little evidence exists regarding best practices for involving entire teaching faculties in the examination of student data to improve classroom practice, especially using newly available technology. The current knowledge base on teacher use of student data is not typically based on the premise that every teacher should engage in data use to inform practice, nor have many studies been conducted in the presence of the widespread, easy data access described here. I advocate that these data systems be used to involve every teacher, not just a core group of interested parties. Further, data exploration with these systems should not become a burden. These systems should make a teacher's day better, not worse, and should help teachers to become more efficient practitioners. This situation presents a unique set of challenges.

In the following sections, I use prior research on data use to help inform suggestions for three important areas of support for teachers using these systems: professional development, leadership for a supportive data climate, and opportunities for collaboration.

Professional Development

Often, the analyses and inquiry employed to inform instructional improvement are not statistically complex (Herman & Gribbons, 2001; Streifer, 2002). In fact, usually there is a wealth of information available in simple descriptive statistics, easily provided by an adequate data system. The transformation of these data and summary statistics into practical, serviceable information is more difficult and requires proper training and professional development.

The lack of substantial and relevant professional development has been a barrier to many initiatives involving educational change (Newmann, King, & Youngs, 2000), and I anticipate this to be true of any data initiative. Listed by Armstrong and Anthes (2001) as a characteristic of a data-driven district, professional development is particularly crucial to the sustainability of a data initiative involving teachers and technology. Massell (2001) noted that most accountability policies implicitly assume that teachers understand how to turn data into information. Unfortunately, turning data into usable information is not an easy task. Further, most educators are not prepared to view their craft and their students' learning through the information lens (Herman & Gribbons, 2001; Massell, 2001), even in the presence of the type of data access described here.

Professional development for data use in schools is often implemented on a large scale and often without expectation of comprehensive teacher involvement, in spite of recommendations by a host of experts who have suggested that professional development and other forms of educator learning are better accomplished on a smaller, more personal scale (Schmoker, 2004). For example, Massell (2001) found that districts were likely to handle data instruction either through a central office that studies data and dispenses information to school personnel, or through the training of key personnel at each school, who are then responsible for handling the analyses and information for their school. Massell found that teachers were usually left to learn informally from other school personnel, rather than included in a professional development plan.

Large-scale professional development may not be an effective method to involve teachers in the use of new technology. Zhao and Frank (2003) suggested that successful technology implementation is not strongly impacted by large-scale professional development. In their study, teacher-to-teacher interaction had a strong positive impact on teacher use of technology, whereas training provided by the district did not. The authors asserted that the positive, informal help that teachers provide to each other—along with pressure to keep up—leads to the survival of a technology initiative.

Resources and guides for specific activities and topics to include in professional development for data use do exist (e.g., Bernhardt, 2004; Johnson, 2002; Wellman & Lipton, 2004). One practice that shows particular promise is the delivery of professional development and data support through an in-house expert, implemented in varied forms. Nichols and Singer (2000), for instance, described the use of "data mentors," where selected personnel from each school were trained in data techniques, then provided data analysis for teachers and helped support teachers in their own data use. Symonds (2003) advocated "classroom coaches" to support data use in addition to larger level professional development. Zhao and Frank (2003) described a situation in which teachers were allowed to learn on their own but were also encouraged to be part of a group that met regularly to help each other learn from data. In my own informal school observations, I have seen many situations in which a person on the school faculty became a de facto "go-to" person, serving as an unofficial "data facilitator" for both interpretation of data and the use of technology to deliver data.

The use of these tools must be augmented with relevant, ongoing professional development, regardless of the specific form chosen. Such support should be crafted with a careful eye to the unique situation presented when promoting widespread teacher involvement in data use.

Leadership for Supportive Data Climates

Successful implementation and teacher use of a data presentation system requires that the data initiative be supported by strong leadership. School leaders must not

only model use of data but also establish conditions that support and encourage teachers to grow in their use of the system.

Fullan (1999) described the importance of strong leadership in any organizational initiative, and implementation of a successful data use initiative requires the same. Armstrong and Anthes (2001) and Massell (2001) both found that strong leadership and a supportive culture were characteristics of the schools in their studies that were most involved in data use. Symonds (2003) presented data that showed schools that were most proficient at closing the ethnic achievement gap were more likely to have school leaders who encouraged or led data-driven inquiry into the nature of the gap.

Leadership for inquiry through data use likely will involve a change in school culture and necessarily will involve teachers. In discussing the application of distributed leadership for inquiry, Copland (2003) noted that the structure for efficient inquiry must be allowed to evolve within the school context, with diverse individuals eventually assuming varied leadership roles. I believe that such an evolution will be particularly important in building teacher use of student data, given the frequent misalignment between teacher views and policy definitions of appropriate goals for student success. Ingram et al. (2004) found that teacher definitions of academic success were often more broadly defined than definitions set forth by accountability policy. Even in schools selected for exemplary improvement practices, teachers were found to rely heavily on anecdotal information in evaluating their students, often eschewing mandated assessments as merely necessary requirements.

The results from Ingram et al. (2004) highlight the importance of leadership to engage entire faculties in conversations to establish common goals and definitions concerning meaningful data. These results also highlight an important but often overlooked aspect of teaching culture: the importance placed by teachers on their own professional judgment. As professional educators, teachers rightly consider their judgment to be an important piece of knowledge, so they are likely to resist any initiative that ignores this judgment. Thus, it is important for school leaders to include teachers' professional judgment as a component of the information process—a data point, alongside such quantified data as assessments. As Black and Wiliam (1999) stated, "One strong reason for giving teachers a greater role is that they have access to the performance of their pupils in a variety of contexts and over extended periods of time" (p. 147).

Leadership support also includes allowing time for educators to immerse themselves in daily inquiry into their classroom practice (Armstrong & Anthes, 2001). Preliminary evidence suggests that teachers will embrace a properly supported data initiative when it is seen as an efficient way to improve education: Teachers in case studies often show quick enthusiasm for data when such data provide useful information for their classroom practice (Symonds, 2003), and data initiatives that stimulate a search for new ideas are seen as most successful

for busy educators (Earl & Katz, 2002; Feldman & Tung, 2001; Massell, 2001). Regardless of the efficiency benefits of the time-saving data tools described here, time demands on teachers are heavy, so teachers may participate more fully in a data initiative when they are provided time to do so. The same holds true when incorporating technology into an initiative. Zhao and Frank (2003) noted the importance of offering time to explore newly implemented technology and summarized research showing that teachers are more likely to use a particular technology if it is supportive of their teaching tasks and does not require a great deal of additional personal investment.

Collaboration

The data systems described here present two new issues for most teachers: using software to organize data and using data to produce information. Initial start-up training on both fronts is important, but beyond that, I believe that teachers will best progress as reflective practitioners through various forms of collaboration with other educators.

Collaboration and information sharing is a common theme in educational improvement. For example, Schmoker (2004) cited a large group of prominent researchers in arguing that improvement of the teaching craft is not attained through the isolationism that marks most schools but by frequent discussion and activities centered around teaching practice. Organizational strategists like Fullan (Fullan, 1999; Fullan & Miles, 1992) have noted that incorporating diverse ideas and perspectives is important to the health of any system. Understandably, professional collaboration is easier to implement when a common theme or vision exists; data offer a viable topic because of data's relevance to all involved. Combining a data initiative with professional collaboration not only offers the opportunity for teachers to learn the art of data use from each other but also allows for a fertile exchange of ideas and strategies.

Case studies on data use suggest the relationship between data use and collaboration is a reciprocal one: Data initiatives are more likely to be successful if teachers are allowed to learn and work collaboratively, and the use of data helps foster constructive collaboration (Chrispeels et al., 2000; Feldman & Tung, 2001; Nichols & Singer, 2000; Symonds, 2003). Symonds (2003) reported that teachers using data in schools that achieved a decrease in ethnic achievement gaps discussed data more with colleagues, visited colleagues' classrooms more, and had more general instances of collaboration. The author and the teachers in the study advocated strongly for collaboration as an avenue to enhance the effectiveness of data use. Collaboration should also be a positive force in increasing interest in the data technology endorsed here, along with the technical skills for using these tools. Zhao and Frank (2003) found their teacher interaction construct to be a prominent

factor in teacher use of technology, stating that the survival of any technology initiative depends on a school's social relations. Zhao and Frank also suggested that positive teacher interaction is crucial to the survival of an initiative.

Collaboration resulting from data use can benefit teaching faculties beyond one-to-one relationships. Nichols and Singer (2000) reported increased interdepartmental collaboration as a result of data initiatives, citing one teacher who touted the increased understanding these collaborations fostered. Massell (2001) saw more interschool and interdistrict communication as a result of data use, providing examples of districts that paired low-performing and high-performing schools based on the similarity of their data, and schools that sought out other schools with similar data profiles to explore best practices. In these examples, data formed the common ground on which these educators could meet and adapt strategies from others in similar contexts. Copland (2003) described the process of inquiry with the framework of a "distributed leadership" culture, in which responsibilities for inquiry into the improvement of teaching and learning were shared by administrators and teachers. These studies illustrate that using data within a collaborative framework not only affords teachers more opportunities not only to interact and share ideas but also to interact with and assume a variety of roles in the educational hierarchy.

Although much collaboration will happen as a result of a data-use initiative, it is also wise to establish structures for collaborative data use and to preserve these data tools as main ingredients of collaboration. Examples of these include a form of distributed leadership (Copland, 2003), schoolwide data workgroups, and data committees that support individual data exploration. Although widely advocated, collaboration can be difficult to implement. Gunn and King (2003) pointed out that inattention to school cultural issues, like implicit power relationships, can quickly undermine collaborative work. They also suggested that many pitfalls could be avoided by engaging in substantive discussions of teaching and learning, establishing a collective understanding of goals, and engaging in professional staff inquiry.

CONCLUSION

As Earl and Katz (2002) noted, the use of data for school improvement is no longer a choice; it is a must. Turning data into actionable information is a multifaceted process, and the supporting research base is still young. In this article, I have addressed one component of this process: the use of data-warehousing and presentation tools to help teachers efficiently become more informed, reflective practitioners.

Accountability measures such as NCLB provide for evaluations of districts and schools and have served to bring attention to the large amount of student data available for use. It is also important that schools look beyond NCLB requirements to move student data into the hands of teachers. The software systems described here provide an effective mechanism for this purpose. Whether locally developed or commercially purchased, these tools bring an efficiency and stability to the data process that has been lacking for years. It is my position that without such tools, districts not only may have difficulty meeting minimum reporting requirements but also will likely be unable to dig more deeply into their data and become immersed in the inquiry process.

The prospect of implementing a data-warehouse and reporting system can be an exciting one for many schools and districts. Such a system can provide the spark for a systemwide change in thinking and practice that often comes when a school begins to view student learning through the data lens. These systems are also applicable to any educational context. And although it is true that the implementation of these systems demands a financial investment, this investment can be very cost-effective when one accounts for the potential improvement in teacher practice and student learning.

Much research is needed on the use of these powerful tools. In this article, I have speculated on best practices in the use of these systems, based on research in other settings. Although useful, research in other settings is no substitute for research in this setting, especially in light of the growing popularity of these systems. As school systems move to buy and implement these systems, it is necessary to properly identify conditions in which these tools can be used to best support the conduct of education. Armed with this knowledge, rigorous, controlled studies can then be conducted to describe the degree of value added to the educational experience by different applications and implementations of these systems. I hope to join with other researchers in providing these important pieces to the research puzzle and helping to move these data systems from exciting possibilities to beneficial, invaluable educational tools.

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REFERENCES

Armstrong, J., & Anthes, K. (2001). How data can help. *American School Board Journal 188*(11), 38–41.

Bernhardt, V. (2004). Data analysis for continuous school improvement. Larchmont, NY: Eye on Education.

Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through student assessment. *Phi Delta Kappan, 80,* 139–148.

Chrispeels, J. H. (1992). *Purposeful restructuring: Creating a climate of learning and achievement in elementary schools.* London: Falmer.

Chrispeels, J. H., Brown, J. H., & Castillo, S. (2000). School leadership teams: Factors that influence their development and effectiveness. *Advances in Research and Theories of School Management and Educational Policy, 4,* 39–73.

Copland, M. A. (2003). Leadership of inquiry: Building and sustaining capacity for school improvement. *Educational Evaluation and Policy Analysis, 25,* 375–395.

Earl, L., & Katz, S. (2002). Leading schools in a data-rich world. In K. Leithwood & P. Hallinger (Eds.), *Second international handbook of educational leadership and administration* (pp. 1003–1022). Dordrecht, Netherlands: Kluwer Academic.

Edmonds, R. (1979). Effective schools for the urban poor. *Educational Leadership, 37*(1)*,* 15–27.

Feldman, J., & Tung, R. (2001). Using data-based inquiry and decision making to improve instruction. *ERS Spectrum 19*(3), 10–19.

Fullan, M. (1999). *Change forces: The sequel.* London: Falmer.

Fullan, M. G., & Miles, M. M. (1992). Getting reform right: What works and what doesn't. *Phi Delta Kappan, 73,* 744–752.

Gunn, J. H., & King, B. (2003). Trouble in paradise: Power, conflict, and community in an interdisciplinary teaching team. *Urban Education, 38,* 173–195.

Herman, J. L., & Gribbons, B. (2001). *Lessons learned in using data to support school inquiry and continuous improvement: Final report to the Stuart Foundation* (CSE Tech. Rep. No. 535). Los Angeles: University of California, Center for the Study of Evaluation.

Ingram, D., Louis, K. S., & Schroeder, R. G. (2004). Accountability policies and teacher decision making: Barriers to the use of data to improve practice. *Teachers College Record, 106,* 1258–1287.

Johnson, R. (2002). *Using data to close the achievement gap: How to measure equity in our schools* (1st ed.). Thousand Oaks, CA: Corwin.

Lachat, M.A. (2002). *Data-driven high school reform: The breaking ranks model.* Hampton, NH: Center for Resource Management.

Massell, D. (2001). The theory and practice of using data to build capacity: State and local strategies and their effects. In S. H. Fuhrman (Ed.), *From the capitol to the classroom: Standards-based reform in the states* (pp. 148–169). Chicago: University of Chicago Press.

Newmann, F., King, B., & Youngs, P. (2000). Professional development that addresses school capacity: Lessons from urban elementary schools. *American Journal of Education, 108,* 259–299.

Nichols, B. W., & Singer, K. P. (2000). Developing data mentors. *Educational Leadership, 57*(5), 34–37.

Pardini, P. (2000). Data, well done. *Journal of Staff Development 21*(1), 12–18.

Protheroe, N. (2001). Improving teaching and learning with data-based decisions: Asking the right questions and acting on the answers. *ERS Spectrum 19*(3), 4–9.

Streifer, P. A. (2002). *Using data to make better educational decisions.* Lanham, MD: Scarecrow Press.

Stringfield, S. (1994). Outlier studies of school effects. In D. Reynolds, B. Creemers, P. Nesselrodt, E. Schaffer, S. Stringfield, & C. Teddlie (Eds.), *Advances in school effectiveness research* (pp. 73–83). Oxford, England: Pergamon.

Stringfield, S., Reynolds, D., & Schaffer, E. (2001, January). *Fifth-year results from the High Reliability Schools project.* Symposium presented at the meeting of the International Congress for School Effectiveness and Improvement, Toronto, Canada.

Schmoker, M. (2004). Tipping point: From feckless reform to substantive instructional improvement. *Phi Delta Kappan, 85,* 424–432.

Symonds, K. W. (2003). *After the test: How schools are using data to close the achievement gap.* San Francisco: Bay Area School Reform Collaborative.

Teddlie, C., & Reynolds, D. (2000). *The international handbook of school effectiveness research.* London: Falmer.

Wayman, J. C., Stringfield, S., & Yakimowski, M. (2004). *Software enabling school improvement through the analysis of student data* (Report No. 67). Retrieved December 14, 2004, from Center for Social Organization of Schools Web site: http://www.csos.jhu.edu/crespar/techReports/Report 67.pdf

Weber, G. (1971). *Inner city children can be taught to read: Four successful schools* (Occasional Paper No. 18). Washington, DC: Council for Basic Education.

Wellman, B., & Lipton, L. (2004). *Data-driven dialogue: A facilitator's guide to collaborative inquiry.* Sherman, CT: MiraVia.

Zhao, Y., & Frank, K. A. (2003). Factors affecting technology users in schools: An ecological perspective. *American Educational Research Journal, 40,* 807–840.