

THE WINGSPREAD CONFERENCE
ON TECHNOLOGY'S ROLE
IN URBAN SCHOOL REFORM
ACHIEVING EQUITY AND QUALITY
A SUMMARY REPORT

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INTRODUCTION

MARGARET HONEY and KATHERINE MCMILLAN CULP

The Joyce Foundation convened the Wingspread conference to generate knowledge and ideas to inform its future funding of educational technology partnerships. As facilitator, the EDC Center for Children and Technology (CCT) worked to identify important areas for future work and further collaboration among participants, as well as to create a framework describing the practical and conceptual relationships for technology in urban schools that are focused on substantially improving learning opportunities for students.

We brought together approximately 45 people for this discussion, including current Joyce Foundation grantees, teachers, district administrators, researchers, education advocates, federal and local policymakers, grantmakers, and journalists. All attendees were engaged in defining new ways of working across the research, practice, and policy arenas to improve the quality and scope of technology use in the service of urban school reform.

We invited conference participants to consider two focusing questions:

- What roles can technology play in supporting the processes of urban school reform — in particular, in supporting effective learning for all students?
- How can and should we address the challenges involved in achieving equity and quality learning for all students?

The conference was framed by a set of white papers distributed before the opening session. The authors were asked to write about one of a set of familiar, persistent challenges to making technology use equitable and high-quality in school contexts. These challenges included:

The importance of leadership. Successful investment in technology for learning requires a sustained commitment and a clear vision across multiple levels of the district. High rates of turnover at both district and school levels, conflicting educational priorities, and complex political landscapes all work to impede effective leadership regarding educational technology implementation. Given these realities of school and district staffing, how can educators most effectively take on and sustain leadership roles in their own communities?

Responding to accountability and assessment pressures. Teachers often find that technology can most effectively support types of student work, such as original inquiry and the

creation of complex work products, that are not easily captured in lowest-common-denominator assessments such as standardized tests. Testing pressures often encourage teachers to stick with drill-and-practice uses of technology, away from more challenging ways of integrating technology into their curricula. How can schools be supported in finding constructive responses to the pressures of high-stakes testing and accountability measures?

Sharing teacher knowledge and practice. Across many promising models of teacher and administrator professional development, the question persists of how to leverage expertise developed in individuals. The need for professional development related to technology continues to grow rapidly, mirroring the high levels of financial investment being made in and the high expectations of hardware, software, and Internet access in schools.

Making connections to policy. While many school districts have learned a great deal about understanding technology as a diverse set of tools to be carefully and thoughtfully integrated into curriculum, policymakers treat technology as a single, uniform intervention into schooling that can and should produce a single, uniform set of clear outcomes. Practitioners and researchers are struggling to find ways to communicate effectively to policymakers about their successes with technology in the classroom, and about the level of investment required to sustain their work. How can findings from work that bridges research and practice more effectively inform policy — what strategies are we not using that could help this work have more impact?

Balancing scale and localization. Translating the lessons learned in one site to others continues to be an unmet challenge. How do we identify and spread best practices while maintaining a commitment to localization and the importance of context and ownership? We know that scaling these models of success requires striking a balance between tailoring programs to meet local needs, priorities, and constraints, and committing to core qualities and best practices that are key to the nature of the original program. Creating a process that achieves this balance is a critical part of scaling the many promising practices that already exist in urban schools across the country.

Much of the work of the conference took place in small groups tasked with devising inventive scenarios involving rich partnerships and collaborations around the use of technology to improve and enrich teaching and learning. We believed that stakeholders addressing these issues in different domains could develop more effective ideas when collaboratively approaching similar goals from different perspectives. Much of our conversation focused on defining the characteristics of effective partnerships. Two goals emerged as salient to all participants:

- Improving the ability of researchers, policymakers, and funders to think and work locally to address the needs and priorities of educators
- Improving the infrastructure for communication, dissemination, and the sharing of expertise to decrease the isolation in which many of these parties work.

This report presents revised versions of the white papers that framed discussion at the conference, as well as a concluding paper that reflects on these goals.

TECHNOLOGY'S ROLE IN URBAN SCHOOL REFORM ACHIEVING EQUITY AND QUALITY

An Overview of the Issues

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A primary goal of the Joyce Foundation's Education Program is "to support efforts in technology and education that ensure equitable access for all students and result in school uses of technology that advance student learning." Although this goal is nominally about technology, it is fundamentally about improving the quality of teaching practice. It is also about allocating resources, including teachers and technologies, in ways that decrease the gap between rich and poor, and between majority and minority students.

A tall order indeed, facing formidable barriers. Yet a group of Joyce grantees, including reformers, researchers, practitioners, and policy analysts, is currently tackling this agenda from several different angles. And from their various perspectives, these grantees confront the same basic challenges in one form or another. These challenges are the basis for the conference's five themes: How to make assessment and accountability constructive; create more-effective school leaders; provide better learning opportunities for teachers; spread accomplished practice; and create policies that promote quality and equity.

The Joyce grantees generally share a set of working premises. These are:

- Technology is not by itself a solution to any education problem; it is a tool that holds tremendous promise for motivating, facilitating, and supporting instructional reform.
- The goal of advancing student learning via technology requires thinking about education reform and technology at the same time.
- Serious issues of equitable access to worthwhile uses of technology exist not only among districts and among schools but also within individual schools.
- High-quality teaching is of paramount importance to increasing student achievement.

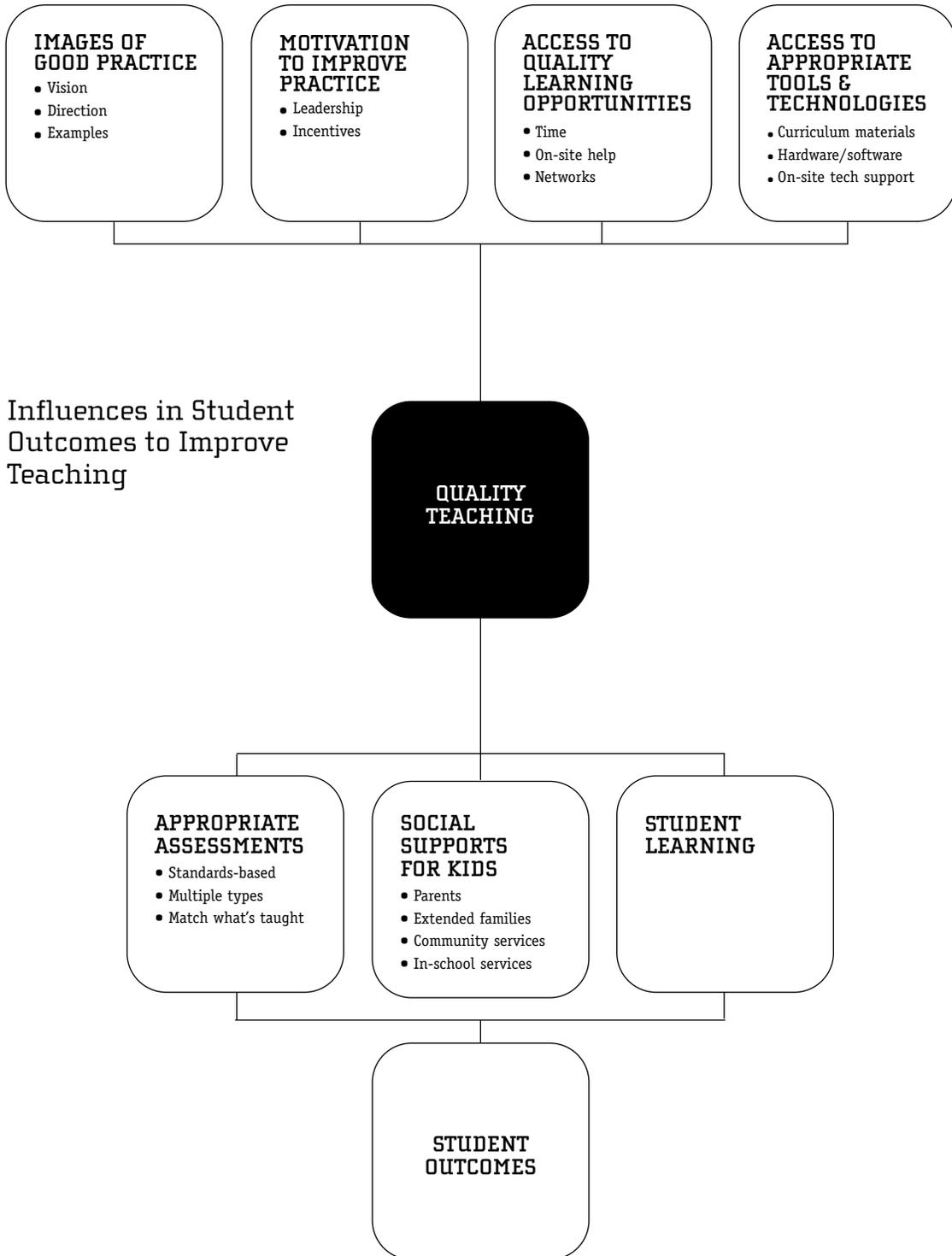
In our work for the Joyce Foundation we developed a conceptual map as a framework for understanding and judging why certain educational interventions are more likely than others to have an impact on student achievement. We also conducted a series of interviews with Joyce grantees. Our conceptual framework and our elaboration of the conference themes incorporate ideas discussed in these interviews.

Our conceptual map places Quality Teaching in the center (Figure 1). This teacher-centric view reflects the perspective that technology interventions can affect student outcomes significantly only to the extent that, one way or another, they end up affecting educational practice: what and how teachers teach, and what and how learning is assessed.

As Figure 1 illustrates, student outcomes are a combination of what students actually learn and how their learning is assessed. Using an appropriate assessment is pivotal, especially when stakes are attached, because of how much the assessment influences the nature of what is taught. Similarly, student learning is influenced not only by the quality of teaching but also by social supports that allow students to bring their full attention and effort to the learning environment. Without these supports, a child may be present in a classroom with high-quality teaching yet be unable to benefit from it.

Interventions may have a positive impact on student outcomes, then, if they contribute to better assessments or better social supports for kids. Even so, teacher quality remains paramount. For this reason the conceptual map spells out and emphasizes the conditions or influences that most directly affect the quality of teaching (beyond how teachers are assigned to schools and students).

Figure 1
Conditions Needed to Improve Teaching



We have organized these enabling conditions into four broad categories:

- *Images of good practice*, such as opportunities for teachers to observe high-quality instructional practice, in person and electronically; clear instructional guidance; and samples of exemplary curriculum units and student work
- *Motivation to improve practice*, including support from instructional leaders and other incentives to devote sustained effort to mastering new skills and knowledge
- *Access to quality learning opportunities*, including intensive summer institutes, onsite work-embedded support, and networks of colleagues
- *Access to appropriate tools and technologies*, such as computers and networks with onsite technical support, high-quality instructional software, and challenging curriculum materials.

Taken together, these four categories embody the idea that for teachers to change their practice significantly, they need to know what to do differently, how to do it, have reasons for changing, and have access to the means to pull it off. We link the four categories together to emphasize that *all four must be met for teaching practice to improve significantly*. Interventions that address all of these categories of conditions are most likely to strengthen core teaching practices. Missing one of them entirely can derail an otherwise powerful strategy.

Equity issues pervade the entire map. Most obviously, access to technology is prerequisite to effective use. Of greater importance is how the enabling conditions and therefore potential improvements in quality teaching are distributed, both across schools and within schools. Students most in need of high-quality instruction are often concentrated in schools with the fewest enabling conditions for improving teacher quality. For example, these schools often lack strong instructional leadership as well as time and opportunities for teacher professional development. Even within schools, the lowest-performing students are typically least likely to have the most effective teachers.

This framework embodies the five conference themes, which capture dilemmas in urban districts faced by all the grantees. *Assessment*, for example, is a key determinant of student outcomes, and influences both classroom teaching and school planning. Given narrow assessment measures and schools' limited capacity to use data well, however, the influences from high-stakes testing are more negative than positive. *Effective leaders* provide clear instructional direction and motivate teachers to change their practice, but given typical administrator training and current definitions of the job, few administrators are prepared to take on these roles. *Quality professional development opportunities* for teachers are the crucial underpinning of instructional change, but they are very hard to come by, as are teachers' time and collegial support for learning. *Scaling up* and the *role of policy* are not explicitly present in Figure 1, but they are the means by which resources and incentives translate into the conditions needed to improve teaching on a broad scale.

Drawing on our interviews with grantees and a subset of the papers prepared for this conference, we now highlight the challenges embodied by each conference theme.

1. Teacher Learning and Technology Professional Development

There is now a firm consensus that the student learning payoff from technology investments will occur only to the extent that technology professional development is dramatically increased. Even where investments in technology infrastructure have been enormous, there have not been even minimally adequate investments on the people side.

Technology professional development cannot be limited to showing teachers how to use technologies themselves; it needs to be embedded in subject matter emphasizing curriculum content, pedagogy, and how students learn. This is the subject of Saul Rockman's paper. Researchers consistently find that teachers discover ways to integrate technology into their instruction when they have internalized active, "engaged" learning as a pedagogical goal for their students. To learn and adopt this goal, teachers need opportunities to see examples of high-quality, non-didactic instructional practice; to discuss and reflect on these examples with peers; to try new approaches themselves; and to receive feedback and support while so doing.

In urban systems it is rare for people in the central office (or in schools) to understand this image of teacher (or student) learning; hence, few resources are devoted to encouraging it. In the Chicago public schools, the Technology Infusion Planning and Web Institute for Teachers summer institute programs are notable exceptions.

Not yet understood by most who fund and design technology professional development is that interventions must go way beyond "how to use the technology" if they are to positively affect student outcomes. To go beyond "how-to" training, technology professional development needs to be repositioned from being a stepchild to becoming an integrated part of all teacher professional development.

Similarly, technology needs to be harnessed to the goal of providing teachers with images of good practices. Although firsthand observation of exemplary teaching over an extended period of time is highly desirable (and something few teachers have experienced even in their own lives as students), limitations of time and access make this unlikely for most. Using technology to capture examples of high-quality teaching and make them available to a wide audience, from the mayor to classroom teachers and parents, can help stakeholders begin to think differently about classroom instruction for the 21st century. Without a clear image of the goal, it will continue to be difficult to garner resources to achieve it, or for teachers to figure out what strategy to adopt.

2. Alternative Assessments and “Balanced” Accountability

Nationally normed standardized tests are the dominant force in public education today. These assessments, consisting primarily of decontextualized multiple-choice items, contradict and undermine the goals of strengthening curriculum and instruction, including those of integrating technology. Actively engaging students in understanding that goes well beyond recall of facts and algorithms is antithetical to the kinds of knowledge tapped by these tests. *Alternative assessments that capture understanding and the ability to apply knowledge must, at a minimum, achieve parity with traditional standardized tests, particularly in today's high-stakes accountability climate.* More balanced assessment systems that incorporate richer forms of assessment, and more balanced accountability that places responsibility at all levels of the system, need to be promoted at the highest policy levels.

Alternative assessments have not gained a foothold because they are viewed as more expensive to administer and score and as less reliable than their machine-scorable multiple-choice counterparts. Technology can play an important role in making such assessments feasible. Until higher-level assessments have a greater profile in high-stakes accountability, student gains deriving from the integration of technology into curriculum and instruction — or any other significant pedagogical reform — will be difficult to demonstrate.

Along with accountability comes pressure for “data-based decision-making,” which asks schools to use data to make and justify program planning. The narrow focus of most external assessments, however, coupled with how and when they are reported to schools, severely constrains their utility. Moreover, principals and teachers have little background or experience in making sense of data or figuring out what to do based on what their data say. As Derek Mitchell and his colleagues point out, the pressures of top-down accountability are ultimately in conflict with school-based inquiry, posing a dilemma for reform-minded educators working under high-stakes accountability.

3. School Leadership

A few school principals are outstanding examples of just how powerful a building leader can be in bringing about education reform. Barry Fishman and Louis Gomez define some essential tasks of leadership, noting that reform depends on leaders, as distinct from managers. *Unfortunately, the vast majority of school leaders do not even see their role as leading and supporting instructional improvement.* They lack the skills and knowledge to play such a leadership role, and are typically overwhelmed by the non-instructional demands of their job. Still, a consensus of researchers and reformers holds that the greatest opportunity to bring about significant changes in practice affecting the greatest number of students is to be found at the level of the individual school.

School principals can almost single-handedly determine whether the school as a workplace creates a climate conducive to teacher learning or not. Similarly, the principal is key in whether

or not powerful instructional uses of technology are encouraged. In Chicago, for example, principals have virtually complete control over how technology is implemented in their buildings. In schools where significant integration of technology has occurred, the principal has brought external resources into the school, changed schedules to create opportunities for teacher learning, and more generally been a leader in promoting and supporting high-quality instructional practice. Principals also mediate the negative influences that standardized tests can play in the instructional program, for example, by helping teachers learn to use disaggregated elements from these tests as diagnostic tools.

Central office staff to whom principals report do little to enhance the skills and knowledge of principals and, like building leaders, lack their own concrete images of what instructional leadership looks like. Yet principals are asked to take on a plethora of new demands, from using data in planning to leading instructional change and introducing technology, for which they have little experience and few supports. As the Fishman and Gomez paper illustrates, the new challenges posed by integrating the Internet into school classrooms are pushing the limits of what today's leadership practices are equipped to deal with. Neither administrator preparation programs nor current selection processes are up to the task of increasing the number of principals able to take on all these new responsibilities. In fact, as the school principal role becomes more and more demanding, new structures need to be created, consistent with notions of leadership distributed across multiple people with different kinds of expertise.

4. Scaling up by spreading good practice

A number of activities are going on which embed technology professional development in subject matter, but most of them affect only a few teachers in one school or a few schools at most. The challenge is how to take existing "pockets of excellence" and turn them into system-wide capabilities; that is, how to spread or "scale up" good practice. All the evidence points to the intrinsic *localism* of each classroom, school, district, and city, as well as their fundamental isolation from each other. As McMillan Culp and Honey discuss in their paper, each success story rests on a series of local particulars that cannot be directly replicated somewhere else. Thus a new conception of scaling up is needed, moving away from the old paradigm — identifying what works in one situation and trying to imitate it elsewhere — toward creating mechanisms, such as networks and communities of practice, through which good ideas can be shared, discovered, tried out, and refined as needed to fit local circumstances.

Despite the sensible logic of focusing on the school as the unit of change, the currently limited pool of effective building leaders and the persistent difficulties of scaling up school-based efforts reinforce the need for an alternative conception of spreading good practice. A different yet complementary approach is to treat individual teachers or administrators as the unit of change, and peer-to-peer networks (or "communities of practice") as the scale-up strategy. This strategy rests on the power of ongoing conversations, collaborations, and mentoring to serve as the basic modes of practitioner learning (rather than isolated workshops or classes).

One example of this approach is the Administrators' Reform Community (ARC), in which researchers participate in the community as both facilitators and formative evaluators. Another example is Tapped In, an online set of tools and facilities ready-made to provide groups of teachers with common experiences and opportunities for chat and forums. Historically, professional associations, especially subject matter associations, have functioned as peer-to-peer networks for those teachers who were already motivated to use them that way.

There are many unanswered questions about how best to develop these networks. It is evident from ARC and elsewhere that peer-to-peer networks are more likely to be effective if *some* combination of outside leaders, experts, and facilitators plays an active role in an otherwise peer-to-peer community. Most observers think that different balances of face-to-face and online structures will best suit different communities. Certain parts of clinical training and mentoring approaches necessarily depend on face-to-face contact, but other parts may be more efficiently conducted online. What balance works best, and for whom? These are leading-edge research questions today.

Peer-to-peer networks of teachers and of administrators could be very efficient vehicles for spreading good practice if combined with powerful and well-packaged images of good instructional practice encompassing technologies. As mentioned above, the networks should also include some participation of outside leaders or facilitators and, until they are well established, a formative evaluation component.

5. Connections to Policy

Federal, state, and district policy all have a role to play in reducing inequities and, at a minimum, removing barriers to quality instruction. Anthony Wilhelm discusses how public policy, and in particular the E-Rate, can effect and affect technology equity. Increasing equitable access to technology is one piece of the puzzle. But even with adequate technology (including the necessary physical infrastructure, from wiring to roofs that don't leak), the deeper inequity is differential access to quality teaching and to schools with conditions that support teacher learning, including strong principals.

Few policies today guide and support strengthening curriculum and instruction in ways targeted to students of poverty and color. In fact, much of current policymaking creates barriers for these very students and their teachers. The narrow focus on assessments and high-stakes accountability as well as the corresponding absence of focus on effective teaching strategies that engage students and develop their curiosity and understanding are impediments to progress.

Introducing technology is unlikely to affect student learning without simultaneously creating a coherent system of professional development for teachers and administrators that includes technology *integrated into* instruction. The revolution in technology further raises a host of new issues that invite scrutiny by policymakers. These include issues of privacy for students and

teachers, as well as issues of commercial intrusion. The poorer the school or district, the more likely it is to sign on to deals that provide technology and dollars in exchange for advertising thrust upon students.

Joyce grantees are facing virtually all of the challenges described above under the five interrelated themes. One premise of this conference is that significant progress will require going well beyond business as usual. The scope and complexity of these issues require different ways of thinking about research and interventions.

We all need to do more learning by doing, through design experiments and other interventions that involve collaboration among practitioners, researchers, and reformers. And we need to invest more effort in sharing knowledge in ways that are useful to and usable by others. These are relatively new kinds of collaborations that cross traditional boundaries between research, practice, and policy.

Benefits from collaborative efforts to create change can accrue to all parties. Researchers who work with practitioners and policymakers in schools and districts benefit from seeing firsthand the complexities of school and district life. Educators benefit from the experience of observing and reflecting on their own situation. Policymakers benefit from a better understanding of the intended and unintended effects of their policies.

In urban settings, where the conditions for success are rarely present, researchers are called upon to exercise sensitivity and frequently to revise their expectations. Similarly, communicating findings to policymakers requires researchers to understand their context and speak their language. These are not traditional roles for researchers nor are these skills typically valued in academia or by most funders of research. This analysis implies a new role for foundations as well, in encouraging and supporting different kinds of collaboration, such as facilitating collaboration among its own grantees, as the Joyce Foundation is doing here.

NEW TECHNOLOGIES AND THE CHALLENGE FOR SCHOOL LEADERSHIP

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In considering the role that leadership plays in the successful use of technology for urban school reform, one must first consider the overall role of school leaders. Are school leaders responsible for setting vision, managing day-to-day business, setting instructional standards, meeting payroll, or communicating with parents and other “clients”? The answer, of course, is all of the above and more. This diversity of potential roles is what makes the job of school leadership so complex. Here we briefly consider the challenges that school leadership faces in bringing the current state of the art in technology into pervasive use in schools.

Writing about organizations in general, a business theorist makes a distinction between *leadership* and *management*, claiming that the former is about coping with change, while the latter, by contrast, is about coping with complexity (Kotter, 1998). The distinction is further clarified through examples of high-level tasks: setting a direction (leaders) vs. planning and budgeting (managers); aligning people (leaders) vs. organizing and staffing (managers); and motivating people (leaders) vs. controlling and problem-solving (managers). “Without good management, complex enterprises tend to become chaotic in ways that threaten their very existence” (Kotter, 1998, p.40). It is clear that schools and school districts, which are very complex enterprises, require good management. But the public rhetoric associated with schooling for the past 15 years has been focused on *reform*, which at its heart is about change. Reform requires leadership.

Educational technology has been a part of schooling since schooling began. The lecture, as devised by Aristotle, is a pedagogical technology designed to facilitate teaching for groups of learners. Less ancient technologies, such as the blackboard and the book, have become standard in the repertoire of schools. But newer technologies, such as radio, television, and now computers, have not been as successful as their predecessors in becoming a standard part of teaching in schools. Cuban (1986) argues that these failures occurred because the technology did not fit well with the accepted routines of teaching; they did not fit the culture of the classroom. This idea was later refined to describe failures of reform in general in terms of a lack of fit between the innovation and the “grammar of schooling” (Tyack & Cuban, 1995). When this “grammar” (culturally acceptable norms for teaching, learning, and managing) is violated, the result is rejection of the innovation.

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The newest technologies, especially the Internet, break with the grammar of schooling in major ways, and for that reason it is the introduction of these technologies that provides the greatest challenge to school leaders. Often schools are encouraged to think of “doing” technology as a thing unto itself. In a setting where the focus is, properly, on reading, writing, mathematics, and science, technology presented as a thing apart will most likely become marginalized.

While the challenge is daunting, we believe leadership that seeks the purposeful integration of technology into the culture of schools can combat marginalization. Vehicles such as project-based learning (e.g., Blumenfeld et al., 1991) and other forms of pedagogy rooted in constructivism (e.g., Duffy & Jonassen, 1992) may give leaders a way to infuse technology into buildings that more easily fits the grammar of schooling. While constructivist reforms also contain elements that challenge the existing grammar of schooling, they have an advantage in that they focus leaders on the essential intellectual work of schools. If technology is thought of as embedded in the core tasks of schooling, its successful integration into everyday practice may be a more manageable negotiation between the culture, capacity, and management and policy norms that exist within the school or school system. Technology demands on those elements of the school system may seem more rational when technology is treated as part of the intellectual fiber rather than something new and essentially apart (Blumenfeld, Fishman, Krajcik, Marx, & Soloway, 2000). Overseeing the process of negotiating the “fit” between innovations and established school practices is perhaps one of the greatest challenges facing school leaders today.

Leadership as a Practice and as a Process

New theories of learning and cognition, such as social constructivism, have not only helped us think about teaching. They also shape the ways in which we consider the role of the individual in an organization, and the way that the actions of a leader can be shaped as much by the tools and resources available, and by the actions of others, as by the knowledge and intention of that leader.

For example, many instructional reform efforts have focused on improving the skills and knowledge of individual teachers, because prior conceptions of instruction have been focused on the teacher, alone, as the single important variable. But instruction is really an interactive system comprising teacher, students, and materials (curriculum and technology), argue Cohen and Ball (1999). They go on to argue that if “instructional capacity is a property of interactions among teacher, students, and materials, then interventions are likely to be more effective if they target more interactions among more elements of instructional units, rather than focusing on one element in isolation from others” (Cohen & Ball, 1999, p.7).

Spillane and his colleagues extend this view of instructional reform to create what they call a *distributed framework* for investigating school leadership as a practice, looking at the “dynamic interaction between multiple leaders (and followers) and their situational and social contexts” (Spillane, Halverson, & Diamond, 1999, p.5). Their working definition of leadership is premised on three assumptions:

- Leadership is best understood through the *tasks* of formal and informal leaders.
- Leadership is *stretched over* the practice of actors within an organization.
- Leadership is *distributed* through the materials and symbolic artifacts in an organization.

They thus define instructional leadership as “the identification, acquisition, allocation, coordination, and use of the social, material, and cultural resources necessary to establish the conditions for the possibility of teaching and learning in schools” (Spillane et al., 1999, p.15). Spillane et al. go on to summarize the extant literature on leadership into the following “essential functions of transformative leadership”:

- Constructing and selling an instructional vision
- Developing and managing school culture conducive to conversations about the core technology of instruction by building norms of trust, collaboration, and academic press among staff
- Procuring and distributing resources, including materials, time, support, and compensation
- Supporting teacher growth and development, both individually and as a faculty
- Providing both summative and formative monitoring of instruction and innovation
- Establishing a school climate in which disciplinary issues do not preclude instructional issues.

The Internet: The Most Challenging Educational Technology Yet?

The Internet, we argue, represents a new class of technologies for classroom use that is more difficult to integrate into schools than previous technologies. Unlike previous computer technology, such as early integrated learning systems (ILSs) (Newman, 1992) or drill-and-practice software that are self-contained and controlled entirely from within the school or within the classroom, the Internet is a classroom technology that requires coordination between the classroom and the outside world in order to work.² There is potential for difficulty at all levels: the teacher and students using the Internet as a learning tool; school-level administration arranging for teachers and students to have access to the Internet during instructional periods; the maintenance and support of the Internet at both the school level and the district level; and the provisioning of the Internet at the district level. Some of these areas have been well researched, particularly issues relating to how teachers and students use and learn with the Internet in the classroom (e.g., Fishman, 1999; Fishman, 2000; Levin, Kim, & Riel, 1989), but most, particularly the areas related to management and support of the Internet as a learning tool, have not, so there are few guidelines for school lead-

² One might argue that instructional television (ITV), a technology popular in the 1960s, is also an example of a technology that required such coordination. In large part, ITV failed to be widely adopted because of these coordination issues, in that teachers were not comfortable setting their teaching schedules by the broadcast schedules (Cuban, 1986). ITV was supplanted by the use of VCRs in the classrooms, effectively restoring control to the teachers and making television a technology that could be controlled entirely from within the classroom by the teacher.

ers venturing into this new domain. As with any new practice or tool intended for the classroom, leaders need to create opportunities for teachers to become comfortable with aspects of teaching and classroom management that relate to the use of the Internet (Marx, Blumenfeld, Krajcik, & Soloway, 1997). We will not pursue within-classroom issues at length here, as they are at play in all situations whether or not one is attempting to introduce a technology such as the Internet in a systemic manner. The present lack of adequate professional development for teachers on the use of technology has been well documented (CEO Forum on Education and Technology, 1999).

For the individual classroom teacher, the Internet is challenging above and beyond issues of whether or not students are learning, because the Internet connection to the classroom depends on the cooperation and coordination of multiple levels of the school system. A teacher can plan a lesson using stand-alone software and, assuming that the computers are working and available (which depends on having building staff who are knowledgeable about computer maintenance, another difficult issue), be reasonably confident that all will go as planned. The Internet, on the other hand, may not be available when needed, and no classroom teacher can predict ahead of time (even minutes ahead of time) whether or not this will be the case. Our experiences to date indicate that in K-12 settings, the Internet is down more than it is up, making such planning a gamble for teachers. But the problem is even more complex than it seems. When the Internet is down in the classroom, the problem could be: a) the configuration of the individual computer or its software; b) the wiring or hubs in the room; c) the wiring, hubs, or routers in the school building; d) the wiring between the school building and the network office (usually located in the central school administration building); e) the wiring, routers, software, or hardware in the network office; or f) the connection to the Internet provider "upstream" from the school district. Alternatively, g) even with no physical problem *anywhere* in this complex system, the individual Internet website or sites the teacher or student was trying to reach may be momentarily unavailable. For a teacher to feel confident enough to use the Internet in everyday teaching, there needs to be a tremendous amount of coordination among different levels of the school system to provide a reasonable level of reliability and reassurance. After all, given all of the different places at which Internet connectivity *could* fail, who can or should a teacher call when there is a problem?

We posit that traditional school management practice has not kept up with the technology it seeks to manage. Consider for example the "help desk" that many districts institute to handle computer problems. The help desk as a solution has its roots in industry, which has a different cost-support structure than is typically found in school districts. These phone-in systems are not convenient for teachers with no phones in their classrooms, and they are not designed to handle "emergencies," such as a teacher whose lesson requires Internet access but who finds that the network isn't working. The help desk typically is designed to record problems, assign a "job ticket," and dispatch the appropriate resources to fix the problem when they are available. Many teachers and building administrators have told the authors that rather than wait for repairs using this cumbersome method, they have, on their own, turned to outside contractors to repair problems. Unfortunately, these outside contractors frequently make repairs that are not compatible with the standards for computers in the school district, or they take advantage of schools in other ways,

such as using substandard parts. Everyone seems to recognize this as an important problem to solve, but the cost of solving the problem (in terms of personnel) is so high that no solution is forthcoming. This disconnect is, at least in part, rooted in technology management and leadership practices that are optimized for older, less interconnected and immediate technology.

The Dichotomy Between Business and Academic Computing

The help desk as a problem-solving mechanism is rooted in centralized administrative services for such tasks as payroll, human resource management, and similar business functions of the school district (as opposed to educational or curricular functions). These centralized organizations go by various names but can be referred to generically as “management and information services” (MIS) departments. As most school districts used computers and networks for the management of their business functions long before the classroom use of computers became popular (Hodas, 1993), these MIS departments were logical candidates for overseeing the purchasing and use of classroom computers as well, since they already had experience with the required technologies.³ These organizations had not previously had to cope with the highly interactive and interconnected curriculum and education applications made possible by the Internet in the classroom. This new role for MIS is giving rise to new problems and a new need for organizational coordination.

Coordination and Support

Another indicator that school leadership practice has not kept pace with current technological realities is the coordination between the school district and outside contractors who provide Internet services. For example, in the past when school leaders interacted with the phone company, its coordination extended only to the central office and minimal phone service to individual schools. The advent of the Internet has changed this.

In one district where we have worked, the school district needed to coordinate with the local phone company in order to have high-speed Internet lines installed connecting the schools to the central office. At the point where the phone company started to install the necessary lines, however, a coordination problem arose — nobody at the school sites was qualified to oversee the installations. At one school, a ditch for new cabling was dug and then refilled before the actual cable was laid. At other schools, the phone company installed the Internet services (and began charging the district for them), but didn’t tell anyone that the work was completed so that district personnel could complete the hookup inside the building. In other schools, building administrators were not clear about which classrooms should receive Internet services, so that initially the network was not established for the teachers who needed it most. All of these issues were related to coordination problems among the different levels and departments of the school district.

Our point here is not to vilify the phone company or school leadership. Rather we want to point

³ It should be noted, however, that much MIS expertise was rooted in the support of the large mainframe computers typically used to handle tasks such as payroll, and the arrival of desktop PCs was, in itself, a challenge to the structure of these departments.

out that the day-to-day practice of leading and managing schools has become out of sync with the technology that makes these mishaps possible. In a world where the practice of leading school districts is in sync with technology, both the phone company and school leaders would have foreseen the pending disconnect. We would expect that individuals in either the school system or the phone company could have prevented many of these problems, had they been empowered to do so. However, without organizational structures in place to “mine” and manage the required expertise that is distributed across people, it is nearly impossible for the appropriate connections to be made.

The foregoing discussion is not meant to imply that there was no success. In several school buildings, computers did function well and teachers were able to use them for instruction. Where this was the case, it was attributable to the presence of someone inside the building (e.g., a computer teacher or support person) who had a good understanding of computers and who understood the intent of the reforms that the technology was intended to support. The presence of a skilled computer support person⁴ is usually a reflection of the building-level administrator’s understanding of the difficulty in maintaining computers and the importance of “local” expertise. However, even in schools that had such a person, the Internet remained problematic because it requires coordination beyond the school building. Our claim is that these people and others would have been much more successful and valuable to the system had management and leadership practice evolved to the point where the organization was better situated to use their insights.

Policy Related to Security and Safety

We offer one final example of the evolutionary challenges in management and leadership as they relate to technology. In our last example we focus on security. Key internal records such as grades and human resources information must be protected from outside attack, and children and others must be protected both from objectionable materials and objectionable people. The Internet, clearly, did not create these problems. It does, however, challenge leaders to think differently. Most districts have “acceptable use policies” for students, teachers, and other personnel who use the Internet (Fishman & Pea, 1994), but these are just a first step. A common solution to these problems is to operate a “firewall” computer that monitors all requests for information from the Internet and allows access to approved sites and denies access to sites that are not approved. Firewalls seem to make sense, given the historical tendency of MIS departments to worry more about protection of information than access to it. The problem arises in that the firewall can create a bottleneck that makes the network unusable at times of peak demand. Firewalls by default also block access to new forms of network tools, such as those enabled by Java applets. Problems such as this pose particular threats to the innovative use of technology in schools, as the security system design can inadvertently make it very difficult to implement more advanced forms

⁴ While the issue of personnel is important, we will not go into it in depth for reasons of space. Ideally, we believe that schools would have a “technical support person” as an FTE (full-time equivalent). No principal would open his or her building without an engineer on the premises. We think that principals should do the same with regard to someone who, ultimately, will be critical in the support of the learning infrastructure in the building. Currently, such roles are assigned to classroom teachers who have enthusiasm, but limited expertise and/or time.

of technology for learning as they become available. The firewall, like the help desk, is a tool of management that does not take advantage of the affordances of the technology. Rather than making the technology more useful, these forms of technology likely stymie its effectiveness. We do not have the “correct” answer to this dilemma. The answers rest in the experience of school leaders. We do believe that school leadership practice in these and other domains will evolve. The evolution will compel leaders to adjust time-honored practices to the new Internet age. We further conjecture that with the proper scaffolding, this evolution will be spurred to meet the needs of schooling with technology with a much more coordinated response. We turn to this point in our summary.

Summary: Roles and Challenges for School Leadership

In summary, the core challenge for educational leaders is to guide the implicit and explicit negotiation process that must occur to match the demands of innovations, including new technologies, to the existing culture of the school system. Along these lines, from our experiences to date, we have identified the following key issues to which central office and building-level administrators should attend:

- Acquire the technology. We start here because nothing substitutes for hands-on experience with technology. Every district, and school community, will experience the introduction of technology differently. Therefore, for all other advice to make sense, it must be constituted in the context of local experience.
- Coordinate and align curriculum, pedagogy, and assessment. Recognize and articulate the curricular reasons for the technology to be implemented. We conjecture that leadership and management, with respect to technology, will be made easier if guided by a curricular vision. Curricular mandates and vision will serve as a partial guide for the myriad of decisions with which leaders must contend. Part of this guidance will come from external calls for accountability in light of school goals and newly emerged standards.
- As Spillane et al. (1999) suggest, recognize and design organizational structures that take advantage of the distributed nature of expertise. Leaders should 1) convene and coordinate corporate and other institutional partners, 2) mobilize teachers, parents, and school partners in pursuit of school goals, 3) cultivate norms of professionalism among all staff members with respect to each individual’s role in the health of the technical infrastructure, and 4) provide professional development opportunities for teachers.
- Make the rationale for technology support public by 1) setting technology policy and standards, 2) coordinating and implementing strategic planning, and 3) maintaining public technology resource inventories (e.g., lists of contractors, in-house experts, etc.).

The essential point in this essay is that school leadership, as it concerns technology, is currently under profound renegotiation. Most schools leaders today are in the early part of the learning

curve. We need to get smarter about how to encourage and support new learning. The Joyce-funded Administrators' Reform Community project is one such attempt. We also need to encourage school leaders to be more reflective about how to use all the things they currently know, in productive ways, to meet these new challenges. We, like others (e.g., Brown & Duguid, 2000), think that part of the solution lies in community. If communities of school leaders can be formed and can shape themselves into new communities of practice that share and develop expertise, new sense-making with technology will come about more rapidly. Today's school leaders have not failed in technology implementation. Rather, as with the earlier experiences of their private-sector colleagues, they must evolve new practice to seize new opportunities.

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COMPUTER SOFTWARE SYSTEMS AND USING DATA TO SUPPORT SCHOOL REFORM

The Quality School Portfolio Decision Support System and New Accountability Initiatives

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The QSP Decision — Support System and New Accountability Initiatives

Accountability and assessment are at the heart of today's school reform efforts. Strong accountability mandates, with heavy stakes attached, are sweeping the country at every level — federal, state, and local. No longer satisfied with business as usual, the public and its policymakers are demanding that schools focus on achieving high standards for all children and are beginning to require some visible evidence of progress toward those standards. Many new accountability mandates reflect new expectations for learning and demonstrate renewed commitment to closing the traditional achievement gap between rich and poor, students entering school with and without full English proficiency, and other special subgroups. But policies such as these also pose substantial challenges to the traditional sources as well as uses of school information. In essence, no longer are important school decisions to be made solely on anecdotal evidence, personal preference, or historical precedent. Rather, data-based decision-making and use of data for continuous improvement are the operating concepts of the day. School leaders are expected to chart the effectiveness of their strategies and use complex and often conflicting state, district, and local assessments to monitor and ensure progress. These new expectations, that schools monitor their efforts to enable *all* students to achieve, assume that school leaders 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 adaptive.

This brief will describe several projects at the National Center for Research on Evaluation Standards and Student Testing (CRESSST) that test the assumption in two of the most challenging academic arenas in the country, Los Angeles County and Chicago Public Schools. Strategies undertaken in developing the software system to support continuous improvement are briefly discussed and the preliminary findings summarized.

The CRESSST Quality School Portfolio (QSP) Project has for the last two years focused entirely on understanding what is needed for schools to be able to make such sophisticated data analysis and integration processes a natural part of their organizational and cultural practice. We have been developing strategies by which schools can gather, maintain, and use data to inform goals and

monitor student progress. The initial vision was one of “technology to the rescue.” We could see that the age of accountability was approaching and believed that schools would need technological support to stay ahead of that wave. Our evaluations of existing software products and the research projects using them led us to a set of guiding principles for our own work on developing a system that not only met the school-level reporting needs, but that we also believed would facilitate the continuous use of appropriate data to fine-tune a school’s educational processes. The ideal is for teachers, principals, and districts to be able to disaggregate data along any number of categories (e.g., student transience by school or neighborhood, vocabulary achievement by gender, individual math achievement in a single classroom), analyze that data with functional ease, and receive the results promptly enough so that individuals can make informed, timely decisions about how to proceed.

The Needed System Must Be Customizable by *School* Personnel

One lesson learned in our work is that too often current student information systems require custom programming to create a report to answer a question that has never been asked before (e.g., What is the relationship between attendance rates in a specific after-school program and changes in student achievement?). This difficulty rests most specifically with the data-warehousing systems in place in most large districts. In order for a school to answer a new question, or even receive reports disaggregated in an unusual manner, forms need to be filled out, sent to the district, approved by district personnel, assigned to a programmer, implemented effectively via custom programming, and delivered back to the school making the request. This time-consuming process often returns data that are inaccurate or at the very least no longer important by the time they become available to whoever asked for the information. For this reason, it was clear to the designers of the QSP system that the data must reside with the administrators and teachers at the building level who need it to monitor improvement, and it must be housed in a system that does not require a programmer and/or a Ph.D. in statistical measurement to use it.

The System Must Disaggregate With Flexibility

Answering questions posed by school personnel often requires the ability to drill down in a database to uncover information about a particular grade or classroom as distinct from being given data about an entire district of 300,000 or more students. Even the requirements of federal Title I programs (multiple measures and specific programmatic disaggregations) call for more freedom with queries and reports than provided by most systems. Data warehouses as initially conceived would not meet the requirements — even if they held the needed data — simply because they lack the requisite query capability. Schools need the ability to add to the data indicators (such as homework completion percentages) of importance to them and to easily design queries that integrate their local data with those of the legacy systems.¹

One example from our research involves a school interested in figuring out a way to increase student performance in mathematics. The reports provided by the school district revealed the school averages only by the traditional variables: grade, bussing, ethnicity, etc. The school initially sus-

pected that students from particularly low-achieving feeder schools would have the lowest math scores and decided to use QSP to add additional sources of data — prior school, prior school math curriculum — as several approaches to elementary math were being utilized in the district. The first disaggregation revealed not only differential progress for bussed and local students, but also particular problems at the tenth-grade level. Investigating further, they again looked for an explanation at the feeder-school level — that is, were students from the local junior high school and the bussed students who had attended that school performing differently than students from other non-local junior high schools? The answer was yes, the students from the local junior high performed worse. And while the question provokes concerns about whether the high school team was attempting to place responsibility elsewhere, the team ended up discovering an important curriculum alignment problem. Students from other areas generally took algebra in their middle schools, an advantage when they entered the high school, which offered a nontraditional math sequence. Thus, there was a challenge for local students when they entered the high school math curriculum. The team then also asked how well bussed students who attended the local middle school (and were exposed to an aligned curriculum) and who had participated in a special mathematics program at the junior high school performed compared to similar students not participating in the program. Results were promising and stimulated the school to think about additional supports entering students might need to make the transition from one type of math sequence to another.

The System Must Be Designed With the Help of Practitioners in the Field

We specifically asked that users of the technology in schools identify sections of the program that would be most helpful to them, and to note where the program could be improved to meet their needs better. In addition to those in our initial pilot, through involvement with other groups in the Midwest (i.e., Chicago Public Schools [CPS], School Change Through Inquiry Project [SCI], North Central Regional Education Laboratory [NCREL], and Wisconsin Center for Educational Research [WCER]), we were able to clearly identify sections of the program that could be augmented or adapted to meet the needs of schools in Chicago more completely. A number of our suspicions about the necessary functionality of a school-based decision-support mechanism were confirmed by interactions with our initial pilot personnel and later verified by others who are undertaking the task of helping schools use data. For example, when data can be refined to show weaknesses in certain skills, such as problem-solving, or due to previous preparation, for specific grades, classrooms, or individual students, teachers and administrators can know where to allocate time and energy.

Our objective was to use technology to mitigate the twin terrors of *access* to data and *control* over it. We felt that if we could prototype the software functionality that schools need to use data dynamically, proactively, and informatively, then watch as a few carefully selected schools engaged

¹ Legacy systems are business information applications (e.g., accounting systems, personnel systems, inventory) already in use when some new system, usually a more modern application with the ability to integrate older systems, is being introduced or discussed. The term is a euphemism for “old”; today’s new systems will be tomorrow’s legacy systems.

in technology-supported inquiry to discover the sources of deficits and strengths, we would eventually be able to articulate a model by which the rhetoric of data-driven reform could be actualized. We're only two years into a four-year research project aimed at fleshing out a model, but our findings at this point have already demonstrated considerable national interest.

Preliminary Findings

We are using multiple approaches to evaluating the process and impact of our work in schools. First, we have established baseline information about the status of data use at each of our participating schools. Each school has completed a data-use survey that addresses issues of access to, trust in, and perceived usefulness and actual use of various types of data, including student background, standardized tests, achievement tests, performance-based tests, attendance, dropouts/suspensions, discipline, report card grades, classroom testing, and other forms of data. Respondents are also asked to rate the importance of these data in school decision-making. We look for project impact by examining these same issues at the end of each year, and will report a summary of them at the end of the four-year project. The results of baseline data collection across all QSP sites can be regarded as a look into the actual needs at the school level for decision-support technologies that go beyond what is in place in most districts and schools. A synopsis of our initial findings (after two years) is below.

1. The questions necessary to drive reform at any particular school cannot always be predicted, and therefore can rarely be probed using data gathered for district-level reporting purposes. The indicators themselves need to be stable enough to withstand disaggregation along multiple dimensions at once, while providing the flexibility needed to inform classroom practice.
2. Most school personnel are not prepared to undertake processes of deep inquiry and will resist being trained to use data to drive decisions unless:
 - a) a systematic emphasis, one that can engender some confidence in the relative importance placed on the task, is established
 - b) belief in the consistency and longevity of the sustained effort itself can be maintained
 - c) the inherent expectations in terms of time and energy are made apparent.
3. The new high-stakes accountability efforts produce pressures that are often at odds with true reform. The pay-for-performance and no-social-promotion policies have decidedly negative side effects, one of which is an unhealthy preoccupation with increasing standardized test scores, "by any means necessary."

Comments by school personnel trained in the use of QSP provide some glimpses into the confusion and strain these legislative measures cause school leaders. One school administrator called "no-social-promotion" policies the district's "thinning the herd" policy. Another challenged the prevailing belief that tests can solve a problem rather than indicate the presence of one when

she asked, "When will these tests actually measure what is really important — the quality of the interaction between the teacher and the child? How can a standardized test given to a student begin to speak to what real learning is about? Isn't all this distracting us from what really matters?"

4. The technologies of information systems, unlike the accountability systems they serve, are becoming increasingly simple to operate and understand as schools and districts move to web-based implementations and away from legacy systems.

Despite both the mandates and the rhetoric of data-driven reform and accountability, schools are woefully underprepared to engage in such inquiry with or without technological support. There may well be a wealth of potential data available to schools — a growing number of tests mandated at the state, local, and school levels for various purposes, dropout statistics, attendance figures, course enrollments, SAT and ACT scores, results of teacher and parent surveys. But such data are not easily accessed or available for comprehensive analysis. Looking at the whole picture, understanding what the results mean for the progress of individual students or the performance of special subgroups, is a challenge for most school administrators. Integrating and applying large-scale data with that from classroom practices is virtually nonexistent. Rarely can teachers use data from their state or district assessments to evaluate the effectiveness of a learning technique or grouping strategy. Furthermore, despite the precepts of current standards-based reforms, the power of decentralization, and the importance of teacher empowerment, most educators have little background or training that prepares them to engage in systemic inquiry. Rarely does the teaching rhetoric include programmatic planning, performance-based decision-making, or the intricacies associated with data collection, analysis, and interpretation. Essentially, using information to monitor improvement is a new precept in the culture of most schools.

If not a direct result of these new accountability requirements, certainly one response to them has been the intense interest on the part of schools, districts, and states in acquiring computer software packages that can both support the accountability needs of school and district personnel as well as serve the building-level educational needs of school leaders. The latest student information systems, such as those offered by Oracle and National Computer Services (NCS), have begun to provide more flexibility and greater access to the myriad of student-level data available to the district. The degree to which these systems can support real inquiry depends a great deal upon the culture of the educational settings into which they will be placed and the savvy with which the systems allow schools to tailor information to meet stakeholder needs.

Sociopolitical Perils

That data use in schools is more than a technical/technological issue is apparent from our pilot schools. Ostensibly the same technological processes were initiated in all QSP sites, but our attempts at technology transfer achieved vastly different results. What makes the process more successful in some schools? Certainly, leadership and culture were important issues. For example, we worked with one strong leader who was well trusted and also well versed in and committed to outcomes-based curriculum planning and decision-making. He was also knowledgeable about evaluation and the use of data for improvement. This innovator led the process and was instrumental in creating a team of teachers and administrators focused on improving student learning. He created a culture that supported data use by showing how superior information helps students learn better. Teachers had feared that data would be used to punish or isolate them, unfairly, for circumstances beyond their control. Instead, they found that “drilled-down” data helped them tailor strategies and curricula to address specific areas of weakness. Data grew into a natural element in the team’s view of its role and the nature of improvement planning. Over a number of years, with ongoing support from the assistant principal, the team had adopted an outcomes-based model of planning and saw data as critical in defining needs and assessing progress. At base, they agreed on the goals of their planning activities and were committed to the enterprise.

In cases like the school characterized above, the school teams feel empowered by data and the planning process; they feel confident they can use QSP to improve opportunities for their students. In other cases, however, teachers feel disenfranchised and devalued by the prospect of using data. They fear that the data will be used against them and feel little sense of its potential efficacy. Furthermore, teachers with whom we worked were sometimes distrustful of the administration’s motives, and at odds with other teachers in their departments about the kind of learning processes and practices they should be promoting. Struggles over ideology, competing interests, a we/they mentality — all these conflicts overwhelmed any continuing interest or motivation to use data.

Another example from our work is an elementary school with a history of low academic achievement. Faced with the threat of reconstitution or worse, the school leaders believed that if they could identify a single area for improvement and bring about some small measure of growth, then the pressure would lessen and they could go about systematic reform without the cloud of fear and doubt. When the faculty was told of QSP and the role it would play in helping the school monitor progress and achievement along preset goals, many faculty members became hostile. They believed that the school’s administration would use the tool to decide whom to keep and whom to lose among the teaching staff, and could not be persuaded that the intentions were good. Some went as far as to call for the school’s union rep to intervene on their behalf. Obvious but worth underscoring: A school must first come together as an empowered community seeking agreed-upon goals and be committed to change before any meaningful use of data to support change is possible.

Technology offers one solid potential solution as “smart” system options become more and more available. With QSP, for example, schools can answer basic questions about their progress relative

to goals, performance over time, subgroup performance, and the relationships between various demographic and performance variables. Safeguards can and are being built into QSP to protect against inappropriate analyses (such as restrictions against averaging percentile rankings) and to prompt important questions by providing a key set of starting queries from which they can probe deeper to drive their own hypotheses. QSP will also soon have a tool kit to help schools administer additional, noncognitive measures to monitor their progress and inform their decision-making.

Finally, our work shows the strong and undeniable tension between top-down accountability requirements and authentic, bottom-up school inquiry processes directed at improving student learning. Current policy initiatives put unprecedented pressure on schools and teachers to be accountable and to show progress on what continue to be relatively limited measures of student achievement — in California, for example, the whole accountability system currently rests on the SAT-9, which is not aligned with state standards. Those schools and teachers who are able to show expected progress would reap financial benefits; those who do not may face serious negative consequences (e.g., school takeover and career-affecting “marks” on teachers’ and administrators’ records). Under pressure to show improvement, improving test scores, rather than improving learning, can easily become the school’s target. For some administrators with whom we worked, this indeed was the case. In this context, there is danger that the inquiry process becomes reduced to “psyching out” the important elements of the test (and its subscales) and a guide to test preparation instead of an important strategy to improve student learning. Feeling they lack realistic strategies to improve both, principals and teachers, furthermore, may resort to other means to ensure expected improvements — drill-and-kill curriculum, coursework that focuses only on tested content, a meager curriculum relative to what students really need to succeed in life, or even cheating. Such actions may produce short-term increases in scores, but are likely to have negative long-term consequences.

There also is a philosophical tension here. Accountability requirements seek top-down control, while meaningful inquiry processes require bottom-up empowerment. These truly are competing perspectives on how best to support educational improvement. Can we achieve the right balance to move forward productively? Our work with schools shows some of the challenges inherent in providing technological supports for these processes, but also provides examples of the professionalism and serious inquiry in which many schools, administrators, and teachers are engaged.

This brief utilizes findings from five QSP projects and Data Use Collaborations at CRESST/UCLA. The core of the work is supported by two parallel projects funded by the Joyce Foundation and the Stuart Foundation. A close look at QSP pilot sites in Illinois revealed many of the systemic and ideological challenges noted herein. CRESST is collaborating with the North Central Regional Education Laboratory (NCREL) on that work, which includes both research on use of QSP and guidelines for the product’s development. The CRESST Quality Education Forum (QEF) project provided guidance for our look at educational indicators and data-availability issues. CRESST has teamed with the American Association of School Administrators (AASA) to implement QSP in 15 forward-thinking districts around the country. This report has condensed findings from the first of three large-scale training sessions of cross-functional district teams as a part of that work.

TECHNOLOGY, URBAN SCHOOL REFORM, AND THE SCHIZOPHRENIC NATURE OF TEACHING

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ROCKMAN ET AL, *San Francisco*

As a consequence of a variety of federal and state initiatives, as well as the decreasing costs of computers, access to computers and to the Internet for all students has grown dramatically at both school and home. More than 70% of homes with school-age children contain a computer. And teachers, too, are very likely to own home computers — more than 80% do. As a result, access to technology is quite different than it was when we began to look seriously at the impact of technology on teaching and learning. The promises we made more than a decade ago seem a bit closer to being accomplished.

Teachers are increasingly knowledgeable about how to use technology effectively, especially in schools where resources are plentiful; and those educators who are not yet able to engage technology well have substantial access to professional development opportunities. When we look at how students and teachers use computers to accomplish their work, we can see major changes in what is done in school, how it is accomplished, and what skills and abilities are improved. At least this is the pattern in many of our suburban schools.

Much of the work my group has been doing is in urban schools, places like Boston, Gary, Chicago, Detroit, Indianapolis, and Oakland. These are sites where technology and other resources are not plentiful, where the telecommunications infrastructure is still being put into place (along with upgrades in electrical systems), where working through the bureaucracy is often difficult, and where universities with little knowledge of the reality of urban schools often find themselves partners in school-reform efforts. These are school districts where a crisis mentality, high-stakes testing, and frequent changes in leadership may result in multiple, simultaneous initiatives for school improvement. These curriculum and pedagogical assignments to schools and teachers are often short-lived and inconsistent, occasionally conflicting, and almost always imposed from above. As a consequence, urban school districts have become schizophrenogenic, sending a variety of incompatible messages to teachers that result in confusion, misunderstandings, and often a return to earlier modes of behavior.

Among the conflicting and inconsistent messages that urban districts send to teachers are:

- We will prepare you to use constructivist approaches and provide you with instructional materials that call for this strategy, but expect you to cover the entire curriculum for the grade level and subject area so that students are prepared to take high-stakes tests (unrelated to what you have been teaching) that have serious consequences for promotion and graduation.
- We will judge you and your school based on the success of your students, regardless of your experience, the resources you have, the physical condition of your building, site leadership, and

the background of your students. And, by the way, money has nothing to do with this (as if you don't know the truth).

- We know that students' motivation will increase when they are doing things that interest them, and that engaged learners produce better test scores. But project-based learning, while increasing interest, doesn't give rise to improved basic skills, and we are still using the same multiple-choice tests that have been turning off students and their parents for three generations.
- Along with constructivist instructional strategies, you might want to use alternative assessments, such as portfolios, performances, and problem-solving tests. But the results of these assessments won't count for students' passing a grade, graduating, or determining the quality of your success as a teacher.
- It is important to master technology and integrate it into your instruction in the range of curriculum you teach, but remember this year we are focusing on reading as the critical skill and that is the most important thing you can do. But don't forget last year's introduction of a new mathematics curriculum we're still trying to master, right? And, we are in the process of revising the social studies curriculum, but that won't appear until next year.
- Helping students learn to write using the computer to support the writing process is great, just the right tool for the task. Moreover, writing is such an important skill that we'll test students on it each year, but, we'll make students take the test with pencil and paper because we know they'll cheat by using a computer.

These discrepancies among the messages teachers receive are troublesome because they come from credible sources, such as universities and publishers, or from the power of the business community, or from federal programs and professional associations. Most often they come from state departments of education, where legislative initiatives have created multiple curriculum standards. These conflicts are particularly troublesome for teachers in urban schools because they come from the very groups, such as NSF, that have, with the best intentions, vowed to address inequities and redress the many social problems that plague urban schools.

We see a disconnect between state policy and teacher practice, between curriculum and pedagogical initiatives and perceived needs, or rather between the needs identified at the school site and state initiatives. Many of the schizophrenogenic messages build on the top-down structure of the educational system and the power relationships that sustain it. Why is it that the policymakers, in collaboration with universities and publishers, identify and make explicit the nature of classroom interventions? When do the teacher and the school determine the nature of the initiative? What happened to letting local schools decide what is best for their students? Legislatures, business interests, and policymakers have made multiple standards and high-stakes tests the coin of the realm, and woe to those who don't strive to conform.

Schizophrenic Teachers

At a time of dramatic change, when inconsistent yet insistent messages are given, when teachers feel powerless to influence their world, a disconnect from reality may seem like a reasonable solution to the confusion. At a time of crisis, teachers are likely to become more conservative rather than take risks, regress to more traditional approaches to teaching rather than trying one of the many initiatives thrown at them. Teachers can still close their doors and do what they choose to do.

Building leaders in urban schools are in a worse bind and can't seem to lead their faculty effectively. They are the traditional middle managers in the fight for better schools, feeling the pressure from above and from below. Teachers want clear signals for the many choices they have to make — or they'll close their doors and do whatever they have been doing in the past. However, the increase in data-driven decision-making has meant that information is aggregated at the district and state levels, not at the schools where it is gathered and where it can be useful. Consequently, superintendents, not principals, know more about each school's progress and status based on test scores, student and teacher data, and demographic changes. Increasingly more granular data are available to make decisions about schools and their staff and students who inhabit them, but the data are available only at the highest levels and not accessible to principals. High-stakes test data are sometimes used by the district for punishment and control, and rarely to assist the schools in making better decisions about teaching and learning. While state education leaders and district superintendents assign responsibility to the school site, they don't back it up with budgetary authority and the information needed to succeed. And superintendents in urban districts seem to have a brief half-life; they want test scores — the only metric the politicians use — to go up. So why should they share with school sites, with teachers and building administrators? What's in it for them?

Teachers, on the other hand, are not part of the information chain, unless the principal lets them in. Test scores are usually not available for diagnostic or placement purposes because it takes so long to get the results. It can be months, or even a full school year, between gathering the data and providing useful information to the classroom teacher. Nevertheless, the data do get used to make building-level decisions, without conferring with the building staff about how to interpret it. Schools will be placed on probation solely on the basis of test scores without discussion of why the scores may have been so poor. In any one year, with relatively few students in any one grade, test data are not reliable indicators of how well the school as a whole can perform. The inclusion of a group of low or high performers at a grade level being tested can change the entire school's standings and lead to district or state intervention. With reason, teachers feel displaced and without control over their professional choices when decisions are made without their input, and troubled even more when the decisions are made at the state or district office.

Pressure from above means that principals have to lean on teachers to do what is necessary to raise test scores at all costs. You hear of cheating now and again, but much of the effort to raise test scores happens when teachers stop teaching their subject and start preparing students for the

test. As people whose work takes them into schools to observe and gather data, we know better than to try to talk to teachers or visit classrooms for the two or three weeks prior to testing. While teaching about the test (or even to the test) would not be cheating on the test, we are cheating the children who should be doing other, more important learning instead of practicing for multiple-choice exams. We could extend the school year by several weeks just by putting a moratorium on testing, so that learning rather than preparing for exams can occupy students' and teachers' time.

What Seems to Make a Difference

Even though urban districts seem to be fostering schizophrenia, teachers don't necessarily succumb. We have learned a lot about how to make classrooms work. Just like the conditions that cause the problems, some of the solutions may be conflicting and contradictory, but by placing them in the hands of teachers, by making it their responsibility, their choice, we can improve the mental health of the teaching professionals, and perhaps even change schooling.

If you ask teachers, most of them did not go into their profession because they wanted to manage student learning or facilitate the use of technology; they got in because they wanted to teach. They didn't plan on a career where they would oversee students working individually or in small groups using computers; they planned to teach these students. We've long acknowledged that teachers teach the way they have been taught, and since most have gone from 16 or 17 years of school right back to the classroom, in the front of the room rather than in a seat, they know best only one way of teaching. The teacher stands in the front of the students dispensing information, and walks around, peering at student work, as children individually complete their worksheets or write their essays. If the computer doesn't fit into this plan, then using computers may not be teaching. So why should teachers want to use computers to teach, when they want to do the teaching?

Larry Cuban has been outspoken about the fact that teachers know how to use technology themselves — to create lesson plans and instructional materials — but that they do not know how to use it to teach. Consequently, he says, teachers use computers at home to accomplish their work but don't use computers in schools to teach. Teachers aren't technophobes, he states, just unfamiliar with ways to teach with computers.

I think Cuban is right — as far as he goes. Teachers have computers at home and use them to accomplish their work. But they have yet to see a reason to use them in school primarily because they see computers and other technologies as teaching devices, not learning tools. Unless and until teachers believe that students also have work to accomplish and need the kinds of contemporary tools that will assist their efforts, why should they promote something that will teach?

Cuban is not alone in his thinking about technology for teaching rather than for learning — in the belief that teaching results in learning. Many technology enthusiasts also operate under this perception of the world. They propose creating marvelous multimedia instructional materials that

will teach important concepts in engaging ways. These teaching efforts may be simulations or activities using virtual reality that sweep students along in a challenging problem. These teaching approaches call for a change in pedagogy, a change that may not be welcomed by teachers. The proposed ideas for new teaching solutions merely take control away from the teachers.

Changing pedagogy to use technology well requires a shift in the power balance of the classroom. It means focusing on learning, not teaching; it means providing opportunities, not information. It means teachers relinquishing control over students who have access to computers and the Internet. Students may produce reports that take different forms to portray their knowledge, using software or strategies that aren't traditional. For example, a group report may include a written text by one member of the team, visuals secured by another, and the findings of online research conducted by a third. How does that report get graded? How does a teacher assess the validity of the online citations that go beyond the range that the teacher has experienced? That is difficult in the teacher-centric world that Cuban and others see.

I believe that Cuban's model of learning, not his perception of teachers and classrooms, is faulty. Learners can learn, even if teachers aren't doing traditional teaching; they learn out of school all of the time. Their learning is not often under our control, but they are learning new and important concepts and skills that will help them succeed in the workplace. Students learn to communicate and collaborate with their peers online at home; they learn new technologies and software outside of schools, at community technology centers or Girls, Inc. or by exploring with their friends; they master concepts of visual literacy that are not even considered at school, learning to make digital videos and manipulating existing visual images to create new ones. We're just not party to it.

In Cuban's world, it is an issue of power and control. We ask that all practicing teachers master technology and apply it in the classroom, and that all preservice teachers learn it, too. We set comprehensive standards, not only for students, but for teachers, too. Most professionals learn enough about computers to get their work done, but they don't need to learn more than that. For example, physicians may master a piece of extraordinarily complex software needed for the diagnosis of disease, but not know how to access the Internet. Teachers don't need to master all the software tools to get the best from their students, yet we insist they learn them. Most preservice and in-service technology classes cover the range of standard office software and teach hardware troubleshooting. New national technology standards ask even more. There may be a few second-grade teachers who use Excel in their classes every day, but I'd guess they would be considered unusual.

Students who have access to computers, on the other hand, do learn a lot of applications and a range of technologies. They have become masters of the new, but we often look at their skills as not appropriate for schoolwork, since it isn't anything we've taught them. We haven't accepted a shift in power and control. I'd rather teachers learn to say "yes" when students want to try out a new tool and then teach others what they have learned. Too often we hear, "No, you can't use

that because I don't know how to use it yet." Or "It isn't something we're teaching in school this year." I think students, if given permission, could master and apply technology in amazing ways. When offered challenges and given powerful technology tools, our students can do marvelous things. But how do we get educators to give permission and get out of their way?

We need to free our children from the constraints that teachers impose when they don't know a technology. We need to give them permission to try — and occasionally to fail — rather than preventing them from gaining access to skills and ideas and information that will help them decide what work they want to do and how they want to do it. In our study of schools and classrooms where everyone had a laptop, we found dramatic and significant amounts of role switching. Teachers became students and students became teachers, all with the goal of developing new skills and acquiring knowledge. This is what we, as educators, like to see. Or at least that's what we like to talk about.

Changes in the Classroom with High Access

Technology can be a powerful intervention to change the way teaching and learning take place in urban schools. But we need sufficient amounts of it and sufficient access to telecommunications to make it most useful.

We have been looking at classrooms where everyone has a laptop computer, where computing is ubiquitous at home and in school. What we have seen is a dramatic change in teaching and learning when computing is always available. The change in teaching practice has been a move toward constructivist ideals and pedagogy. Moreover, these changes appear to be coming from teachers' evolving views of how teaching and learning should take place, how resources should be used, and how classrooms should be organized. The presence of ubiquitous computing has been a catalyst for this change, providing a hard-to-ignore stimulus for modifying traditional behavior and for exploring options for new teaching-learning paradigms. Our studies have found increases in independent student work, more collaborative work, more project-based learning, and significantly less direct instruction in laptop classrooms from the very beginning of our three years of research.

While all students have greater exposure to computers than ever before, computer use is significantly more intense for laptop students, most noticeably in school. Students who have a computer all the time have changed the way they work, where they work, and often the kind of work they do. Students now teach other students more frequently than before, and they review and revise their own work more often. But perhaps the most dramatic change, other than the significant shift towards constructivist teaching and learning, is in how often teachers allow themselves to be taught by their students.

What we haven't seen are the substantial gains on standardized assessment measures that many policymakers, legislators, parents, and critics of technology in school are seeking.

One might think that students with ubiquitous access to computers are learning additional content and learning it better, but that may be more a condition of what the teachers are asking of their charges and what the students are bringing to the classroom in terms of previous experiences and family background. Project learning may be increasing in classrooms where everyone has a laptop, but that doesn't necessarily lead to broader student knowledge that might yield results on standardized tests. Writing skills may be improving, but yet we ask students who consistently write, rewrite, and edit on the computer to write in longhand, constraining their opportunity to write the way we teach them to write.

Ubiquitous technology may not be an immediate opportunity for most urban schools. The costs may be well beyond what urban school systems can now afford (even though New York City thinks otherwise). However, the multiple conflicting initiatives that plague urban systems pose additional barriers beyond just adding technology.

These urban systems have tried technology solutions in the past by bringing in full curriculum solutions in the form of integrated learning systems. These short-term solutions to improving test scores, however, bring in problems of their own, adding to the schizophrenia of the schools. Teachers must learn to be diagnosticians and read statistical reports to assign students to the most effective instructional treatment. To most, that's not teaching. Moreover, the teaching itself is assigned to the technology, a double whammy for the teachers.

The thinking behind the changes that ubiquitous computing engenders, the strong stimulus for change that technology offers, can be a critical component of school improvement. By bringing teachers into the decision-making about technology (and curriculum and school-change initiatives), we can strengthen the opportunities that current support for technology offers schools. If teachers can be our partners, just as business and industry can, then technology will not be seen as a threat or as a personal productivity tool for teachers and not for students.

School administrators often perceive and talk about technology as a tool to support and extend teaching, or even to replace teaching staff. Teachers, justifiably, are disturbed that technology is thought of as something that can replace them or alter their role as teachers; they thought their part of the system was sacrosanct and protected. We need to convert this opportunity to inform administrators and policymakers that technology is not only a teaching tool, but, more important, a powerful learning tool that can change classroom culture. As such it requires different ways of thinking about the classroom and its organization, about pedagogy, and about control. These are highly emotional issues for all concerned, but such is the power of the technology to support changes in teaching and learning.

THE CRITICAL ROLE OF PUBLIC POLICY IN PROMOTING EDUCATIONAL TECHNOLOGY EQUITY IN OUR NATION'S URBAN SCHOOLS

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When seeking to improve both the *quality* of education in urban school districts and the *opportunity* for all students to develop their latent talents, decision-makers turn increasingly to technology to deliver the goods. Our nation's schools are certainly not immune to the dramatic changes occurring in the larger society, and many policymakers accept the promise of technology to improve institutions such as urban public schools. As leaders at all levels make the claim that technology is key to prosperity in the 21st century, pressure mounts, particularly in failing schools, to leapfrog their tenuous situation via technology. While this is a noble ambition, the stark reality is that there is no simple formula to integrate technology seamlessly into the learning environment. Hardware and software, technical support, and professional development are expensive, and technology integration and curriculum development are time- and labor-intensive. In short, technology is neither a necessary nor a sufficient condition for wholesale educational advancement. Its effects will be slow to emerge, particularly among certain cohorts, such as at-risk learners in urban settings. Policymakers cannot put one foot in the water: They must immerse themselves in a comprehensive approach to educational technology and make appropriate investments, or technology's failure will become a self-fulfilling prophecy.

The learning environment begins with educators who are ready to teach and students who are ready to learn. As the poet Yeats suggests, education is not the filling of a pail but the lighting of a fire. If this is true, then technology becomes one more vehicle to invite students to construct a more vigorous relationship to knowledge. We cannot, however, build the technology infrastructure and hardwire the schools and expect learning to improve automatically. Many factors influence the quality of education (and quality is determined by the sorts of outcomes we expect from public education), such as the presence of good teachers who are prepared to use instructional technology to reinforce and enhance constructivist pedagogy. A myriad of studies over the years has demonstrated the power of self-directed learning, and management gurus, such as Peter F. Drucker, have noted the critical interrelationship between the activities of constructivist learning — group work, problem-solving, project-based learning, etc. — and the universal literacy required to compete in today's society (Drucker, 1993).

The quality of an educational experience has less to do with how wired a school is and more to do with how these tools are used to reconnect students to inquiry-oriented instruction and to overcome teacher disempowerment. Opening educators to a world of collaboration and curriculum-enriching online content is critical to prepare their learners for full participation in society,

including competing for the 60% of jobs that now require some familiarity with information technology. Policymakers must be open to another way of evaluating educational technology in which the relationship of technology to norm-referenced testing is only one variable in determining how to justify educational technology investment.

Keys to quality classroom engagement with technology are professional development opportunities for teachers and use of certain pedagogical methods that fuel student involvement with computer applications and the Internet. According to data from the National Center for Education Statistics, in 1999 only 32% of teachers in the highest-poverty schools used computers or the Internet a great deal to create instructional materials compared to 52% in schools with the lowest poverty levels. We know that teachers who enjoy more hours of professional development and who have some familiarity and training in constructivist teaching methods are very likely to assign students various types of work involving computers and the Internet (National Center for Education Statistics, 2000). Those teachers with the greatest access to professional development opportunities felt the most prepared to use instructional technology in their teaching.

In terms of achieving greater equality in students' opportunity to learn, unequal technology deployment often drives a deeper wedge between the haves and have-nots. Thus less affluent districts are often playing catch-up to cohorts with higher per-pupil expenditures. A lesson can be gleaned from states' experiments with educational television in the 1960s and 1970s. Some states that were spending very little on public education, such as Kentucky and South Carolina, thought educational television would be the technology that would allow them to leapfrog more affluent states. We know that this experiment has not transformed education, since other, more fundamental, reform issues to raise the level of opportunity in public schools in the South, particularly those serving predominantly minority students, were eschewed. Some districts and states today are investing heavily in hardware and software applications to level the playing field in educational opportunity, repeating the strategy of early proponents of educational television. They will likely see similar results, unless they both tackle fundamental inequities in public education and mitigate the bottlenecks in institutions that prevent reform efforts from flowering.

Although federal Title I monies and the E-rate have plowed billions of dollars into disadvantaged urban districts, a chasm remains in overall access to computers and the Internet between affluent suburban districts and urban schools. In 2000, there were 6 students per instructional computer with Internet access in districts with less than 35% of students in poverty, compared to 9 in schools with poverty over 75% (National Center for Education Statistics, 2001).

A central impetus to infuse technology into underserved schools has been the E-rate, a federal program providing deeply discounted telecommunications services to the poorest school districts. Urban schools have benefited greatly from the E-rate, with city districts in the U.S. representing 33% of the nation's students and 49% of E-rate district funds (The Urban Institute, 2000). With E-rate funds, school districts are able to address the equity issue, because, for the first time, they can afford to begin outfitting buildings with a 21st-century telecommunications infrastructure.

While the E-rate has been crucial, it has not yet closed the access gap between the wealthiest and poorest districts. At the end of 2000, schools with the highest level of poverty and those in cities had the lowest percentage of instructional rooms with Internet access in public schools. Only 60% of instructional rooms had Internet access in the highest-poverty schools compared with 82% of lowest-poverty public schools in 2000. More troubling, the gap actually remained constant between 1999 and 2000 despite accelerated federal commitments to bridge the digital divide in recent years (National Center for Education Statistics, 2001).

The E-rate is just beginning to outfit the nation's public schools with a technology-enhanced learning infrastructure. During the program's first two years, 58% of funding went to support the acquisition of equipment and services for internal building connections, including LANs, PBX, servers, and switchboards. While these are critical components of school modernization, they represent only its first steps. Only 8% of funding discounted the cost of Internet access, although access represents the gateway through which learners can begin to build a relationship with knowledge online. While all of this technology investment is taking place, policymakers — including teachers, principals, district administrators, school board members, and state and federal lawmakers — will need to keep asking the question, How can we turn a 21st-century (i.e., wired) school building into a first-rate learning environment? That is, how can technology best be used to promote learning? In the years ahead it will be critical for E-rate discounts to be deepened and leveraged with other state and federal dollars in order for teachers to avail themselves of tools for online collaboration, student inquiry, and the creation of knowledge in the context of project-based learning.

A recent report from the Benton Foundation and EDC Center for Children and Technology called *The E-Rate in America* revealed that a whole set of policy corrections is needed at this point in time, since we have invested so heavily in hardwiring schools. Let me mention three important policy next steps. First, a significant infusion of technology into classrooms translates into accelerating demand for teacher training, both in-service training and the preparation of the next generation of America's educators. Without a greater allocation of resources, professional development requirements will probably outstrip the ability of many school districts to accommodate teachers. District leaders and principals must be convinced of the importance of continuing to emphasize sustained creative professional development for teachers around the use of these new tools. Teacher colleges must undergo a culture shift in the preparation of teachers, realizing that technology integration is no longer supplementary in the accreditation of teacher education.

Second, we also know that inadequate "building basics" delay the deployment of information technology. Since electrical updates and hardware are necessary prerequisites for Internet access in classrooms, it is critical for state and federal policymakers to invest in school construction and renovation. Schools with leaky roofs, asbestos, shoddy electrical wiring, and no air-conditioning are often unable to build a technology infrastructure, let alone provide an environment in which students and teachers can focus their minds.

Finally, high-level school administrators and community stakeholders need to be made aware of the impact of the E-rate in particular and the importance of information and technology literacy in general. As information technology proficiency becomes vital to full participation in the economy, politics, and society at large, policymakers at the local level will need to make smart investments so that technology enables underprivileged students to feel they have a greater stake in society. A handful of vocal politicians as well as some administrators are lukewarm about the E-rate, in part because they perceive its administration as overly byzantine. Or, they don't see its value when stacked up against what they consider more fundamental "bread and butter" issues, such as teacher pay, performance standards, or in-servicing. Thus much-needed investments languish as administrators fail to see technology development as potentially integral to a range of key educational challenges, such as motivating students and providing new teachers with the pedagogical and curricular tools to excel in their classrooms.

A commitment to equity in education dates back at least to the 1954 *Brown v. Board of Education* decision. Our tradition of a public education system open to all students reflects our commitment to equality. Many state constitutions uphold education as a fundamental right. New Jersey, for example, guarantees all young people a "thorough and efficient education." Some parents and concerned citizens have argued that lack of resources in impoverished districts means in effect that children are being denied equal educational opportunity. "Unless we get equal resources and funding to the poorest schools, there will never be equal education," notes Gary Orfield, professor at Harvard University's Graduate School of Education. "Even with those resources for all schools, there will be some inequalities."

Public policy is about the setting of priorities and the distribution of resources to match those priorities. Of course, there are many layers of policymaking within an urban educational system, including teachers, principals, district administrators, and school board members. With education dollars coming largely from state and federal governments (and fully one third of technology funding derived from federal programs), we end up with a tangled web of priorities and expectations surrounding the role of technology in urban education. Since expectations differ at varying levels within the system, confusion and contradiction plague reform efforts. The imperative arises to align policy with the very real needs of educators on the ground. With the current national focus on an accountability framework wrapped around students' performance on norm-referenced tests, for example, technology investments are justified primarily on their ability to enhance test-taking performance rather than the constructivist goals referenced earlier in this paper, such as problem-solving, team-building, and the like. Leadership must emerge to counterbalance the current conventional wisdom on educational accountability.

Technology has an important role to play in improving education in urban districts — when properly supported and integrated into a learner-centered model of educational advancement. With large pockets of at-risk youth, for example, urban districts become important catchments for applying customized learning approaches that blend technological tools with the right human touch. Such issues as balancing authority and responsibility in schools; ushering in a pedagogical

and epistemological revolution to reconnect students to knowledge; and setting high expectations about what we as a society deem important outcomes of the educational process are not amenable to technological solutions per se. Technology is a tool, and sometimes a catalyst. It is at best an ally in the war to change the landscape of education in the 21st century.

At a time in which good educational technology practice is just beginning to bear fruit there are signs that the national commitment to bridge the digital divide is possibly waning. In the mid- to late 1990s federal funding soared exponentially — from tens of millions of dollars to several *billion* dollars in fiscal year 2001. Over an eight-year period, for example, federal funding for educational technology in the Elementary and Secondary Education Act, Title III, increased from \$23 million to \$872 million. The E-rate program also emerged, plowing nearly \$2.25 billion into schools and libraries in poor and rural communities in 2001 alone to spur infrastructure development. President Bush's educational objectives call for both a decrease in educational technology funding and a dispersion of these funds to the states in the form of block grants. The leadership role of the federal government — always the great equalizer in the perpetual struggle to afford equal educational opportunities for all children — thus becomes muted, both in terms of the use of the bully pulpit and in the allocation of sufficient resources to modernize our formal learning institutions.

It is more important than ever to weave together the expectations of federal, state, and local policymakers so that various funding sources for educational technology contribute to the learning process in a more intentional manner. Since state and national policymakers are caught up in the standards movement and in gauging student performance through norm-referenced testing, it will not be easy to harvest technology to serve constructivist objectives. Instructional technology, however, remains a lightning rod, providing an invitation to sample a range of alternative possibilities in the learning environment that will justify our sunken investment.

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SCALE AND LOCALIZATION THE CHALLENGE OF IMPLEMENTING WHAT WORKS

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The challenge we discuss in this brief paper is the tension between scale and localization as they pertain to the interweaving of technologies into school reform and school change processes. How, in the field of education, do we identify and spread best practices while recognizing the necessity of localization and the importance of context, relevance, and ownership? How do we argue that there are some things that work across a broad range of schools and at the same time assert that no one solution will “fix” every school? We begin by laying out three claims:

- Very little research examines how innovative technology practices and models transfer to other contexts.
- Every time a school takes on a practice or model of technology use developed elsewhere, that practice or model is changed — it is “localized” to fit the particular needs, strengths, and complexities of the individual school (and of the individual classroom or teacher).
- Most (if not all) practitioners and researchers believe that scaling up promising practices and creating locally unique responses to educational challenges are not irreconcilable tasks. In other words, we believe this endeavor should not be cast as an either/or dilemma. We think the issue of scale is anchored firmly in processes that enable schools and districts to localize practices relevant to them.

As David Tyack and Larry Cuban (1995) remind us in their historical examination of school reform, despite more than a century of reform efforts, “educators have variously welcomed, improved, deflected, co-opted, modified, and sabotaged outside efforts at reform” (p.7). If it were easy to transfer effective practices from one setting to another, we would have done so long ago. Based on their experience as senior program officers at the National Science Foundation, Sabelli & Dede (in press) write: “Decades of funded studies that have resulted in many exciting programs and advances have not resulted in pervasive, accepted, sustainable, large-scale improvements in actual classroom practice, in a critical mass of effective models for educational improvement, or in supportive interplay among researchers, schools, families, employers, and communities.”

Researchers working in the area of educational technology and school reform have learned again and again that supposedly “proven” successful practices with educational technology can be adopted locally only when they are made sense of, teacher by teacher and school by school, in relation to teachers’ and administrators’ own challenges and goals. Bringing promising practices to scale, then, is partly a question of outreach and dissemination, but more importantly a question of enabling, at the local level, processes of self-reflection and informed engagement with both

internal and external communities of practice and research. Only through these processes will teachers and administrators be able to say, “That looks great, I can see how it could be relevant to what my schools are doing, and I see how we could make it work for us.”

But what kinds of relationships and programmatic efforts need to be in place to support both localization and scale? As many colleagues in the educational research community are beginning to suggest, we need to take seriously the challenge of working in partnership with schools and districts on terms that are meaningful to the people ultimately responsible for educating students — administrators, teachers, parents, and the students themselves (Sabelli & Dede, in press; Schoenfield, 1995; Tyack & Cuban, 1995; Meier, 1999; Cohen & Barnes, 1999). Different schools have different educational priorities and operate within varied constraints. Their circumstances, such as the populations they serve, the resources at their disposal, and the communities in which they are located, all differ. School change depends primarily on leaders who take initiative but who also have sufficient resources to realize their ideas. (These resources include everything from funding, local political issues, school and district relationships, and school culture.)

Understanding what will and will not work in schools requires listening carefully to find out what the school community identifies as important to its local objectives. This process can perhaps be understood as one of diagnosis — an interpretive or deductive identification of how particular local qualities work together to form the distinctive elements of the school system. This view of diagnostic work is quite different from a more typical approach to educational research, which relies on experimental methods to identify what is uniform, consistent, or generalizable across schools (McMillan Culp, Honey, & Spielvogel, in preparation; Sabelli & Dede, in press).

Much of our understanding of the relationship between technology and school reform as well as the systemic process of change grows out of more than eight years of collaboration and partnership with the Union City Public Schools (CCT, 2000). This district has been remarkably successful in transforming itself from a failing urban system into a district where the vast majority of children are doing well academically. Our collaboration with Union City has underscored a critical fact: that effective school reform — meaning reforms that take root broadly across multiple layers of the educational system, are sustained over time, and result in demonstrable improvements in student learning — does not require technology. But simultaneously, much of what has been accomplished in Union City has been greatly aided by the ubiquitous growth of technology in the schools. In Union City, technological investment was an integral part of a much larger process of school reform. Technological tools were present that allowed for various forms of communication, student production, curriculum development, and collaboration among students, teachers, and administrators, that simply would not otherwise have been possible and that were part and parcel of the school system’s process of change.

Union City also taught us a number of other important lessons:

- Researchers need to honor and privilege the knowledge and expertise of the people who work in schools. Too much work in the education field – whether it be break-the-mold school-redesign

initiatives or education research in general — is characterized by deficit thinking. Understanding schools on their own terms and suspending judgment of what “should” be in place are critical steps for researchers hoping to build effective collaborations.

- It is much easier to work in partnership with a school as a researcher or facilitator than it is to work in a school. As researchers, we do not depend on the school for our livelihood — we can walk out the door and not return the next day. Local educators are the ones who shoulder the majority of risk in reform efforts.
- Urban school systems are not rational environments; they are highly complex, political environments in which multiple agendas operate (some explicit, some hidden). Understanding the local political context is essential to being able to work in partnership with schools. Outsiders cannot do this alone. They need the trust, wisdom, and insights of people working within the system who can help to unpack political complexities.

We have also learned through our experiences with Union City and other reform initiatives using technology that five issues — leadership, core vision, professional development, time, assessment — need to be coordinated in order for meaningful, sustainable school improvement to occur. This process of coordination requires that:

- *Leadership* is anchored in a core vision of teaching and learning.
- Sustained and intensive professional development takes place in the service of the *core vision*, not simply around technology for its own sake.
- The commitment made by the school or district to the process of change, and to the appropriation of particular technologies for particular purposes, is also a commitment to an adequate period of *time* to allow agreed-upon changes to unfold.
- Ample opportunity for adequate *professional development* allows educators to figure out how to use technological tools to assist in carrying out these changes in teaching and learning.
- *Assessments* are developed that enable school leaders and faculty to determine whether they are realizing their goals, and how to adjust if necessary.

CCT has been asking questions about how technology can best support teaching and learning in K–12 schools and other educational contexts for 20 years. This work and the work of our many colleagues has led us to our current perspective on what is important about infusing technology into K–12 education. We have learned that when student learning does improve in schools that become technology-rich, those gains are not caused solely by the presence of technology or by isolated technology-learner interactions. Rather, such changes are the result of an ecological shift and are grounded in a set of changes in the learning environment that prioritize and focus a district’s or school’s core educational objectives (Hawkins, Spielvogel, & Panush, 1997). For some districts, this may mean a focus on literacy; for others, it may be using technology to support high-level scientific inquiry. We have seen that technology does not just bring change to a routine set

of tasks (such as typing on a keyboard instead of writing on paper, or searching the Internet rather than an encyclopedia). Rather, technology enhances interpretive tasks, such as the communicative, expressive, analytic, and logistical capabilities of the teaching and learning environment.

We believe that this type of technology use will happen only when technology is viewed, at multiple levels of the educational system, as a set of valuable tools that must be put in the service of a broader vision of school change (Hawkins, Spielvogel, & Panush, 1997; Chang, Henríquez, Honey, Light, Moeller, & Ross, 1998; Honey, Hawkins, & Carrigg, 1998). Therefore, a crucial part of broadening the effective use of technology in K–12 schools will require committing to a body of work that investigates, establishes, and disseminates research findings that both reflect and speak to the complexity of the daily work of teaching and learning in U.S. schools and school districts. We want to privilege the creation of descriptive, complex models of the role technology can play in addressing chronic educational challenges. These models must take into account the contingency and diversity of decision-making and practice in schools (Robinson, 1998). They must be models that can help practitioners, policymakers, and the public make informed decisions and hold informed discussions about technology investment and infrastructure development. We believe that in order to advance these attitudes, this body of evaluative knowledge must be built, in large part, from explorations of how technologies can help schools and districts respond to locally relevant educational challenges. We know that technologies offer teachers and students opportunities that would otherwise be extremely difficult to realize in classroom contexts. Four areas offering particular promise are assessment, information access, collaboration, and expression, and there is broad consensus among school reformers regarding the centrality of these issues in improved student achievement.

As noted above, the approach that we believe can enable schools to sustain and localize meaningful change is clinical and diagnostic, constructed in partnership with schools, and sensitive to the political realities that schools must often contend with. An often overlooked step in the process of innovating in schools is the identification of the core challenges the community wishes to address. Whether it is effective literacy or mathematics learning at the elementary level, or contending with the high student dropout rates in high school, identifying the focus problem is an important first step. We believe that schools can benefit enormously from collaborations that assist them in this process and from research partnerships that help play a reflective and diagnostic role, but only if such partners are willing to midwife, rather than define, the work of reform.

In addition, sustainable, focused change requires that once the problem areas are identified there is time to research and review how other communities have addressed the issues and then to decide how to adopt and modify approaches that can be tried locally. Also essential is a climate that simultaneously encourages experimentation and revision in the form of small test beds where ideas can be tried and refined and also uses research to focus on the *process* of change and innovation with an eye toward capturing the complex local factors that enable innovations to take root system-wide and yield meaningful results.

Why, then, if we, along with a number of our colleagues, have strong ideas about strategies and practices that can help move forward the creative use of technology in school-change efforts, is it so difficult to move in this direction? By way of conclusion, we would like to suggest several reasons why such partnerships are difficult to accomplish.

First, there is a gap between the kind of research that is privileged in academic contexts and that valued by and useful to educators who work in schools. What teachers want is research that goes beyond outcomes and explains the processes that yield particular results. They want studies that explain and describe the context in which the innovation occurred. As Sabelli and Dede note, however, most educational research focuses on global outcomes and ignores the complex contextual factors that can enable us to understand much more about localization and sustainability. The push for outcomes-based evidence of program effectiveness is further reinforced by both policy-makers and those who fund research and development efforts.

Second, most psychological, educational, cognitive, and learning sciences researchers are trained in traditional research methodologies. Our colleague Jan Hawkins used to say that we need to educate researchers differently. She envisioned a very different kind of graduate education program in which students were not only learning the fundamentals of research methods, but were also engaged in long-term internships in schools and other kinds of educational institutions. Underlying this vision of learning is a commitment to reinventing the research stance that schools are objects of study, in favor of a process that defines research as a collaborative and reflective process.

Finally, effective partnerships and collaborations are built on trust, yet many of us (researchers) who work in school contexts are often laboring under the assumption that we are helping to remedy a deficit. The model of evolving knowledge in the cognitive and learning sciences fields is still very much one of *importing* knowledge and expertise to the school community. Rarely do we take seriously the challenge of evolving knowledge and expertise in collaboration with the school community. Experience shows us, however, that only by creating relationships in which research and practice complement each other — in which knowledge is increased and practice is changed, and both influence the other — will we be able to bring best practices to scale in a way that works for local schools.

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REFLECTIONS

KATHERINE MCMILLAN CULP and MARGARET HONEY

The Joyce Foundation and the Center for Children and Technology convened this conference to reflect on the considerable body of existing knowledge about technology and its role in supporting urban school reform. For some time a number of us in the field of education technology have been troubled by the tension between the amount of knowledge we have accumulated about these issues and the lack of any clear means for sharing, aligning, or building on that knowledge. This conference was an opportunity to confront that tension, and to articulate how working relationships among the various stakeholders might be reconceptualized and what infrastructure would be needed to support new kinds of partnerships among us.

A key focus of our numerous conversations was how the various players represented by the conference attendees — educators, administrators, researchers, policymakers, advocates, and journalists — could best work together to communicate what we have learned about the pros and cons of technology use in urban schools. The emphasis was on seeking new ways for researchers and practitioners to collaborate. We sought to articulate models for collaboration in which schools would act as equal partners with researchers in the project of identifying areas for improvement or investment and tackling them from a position of strength rather than one of weakness or lack of knowledge, resources, or will. We used the term partnership to suggest the kind of approach we were seeking, and worked to identify the key challenges to strong partnerships, as well as the qualities research partnerships would need to overcome these challenges.

This paper presents three sets of issues that emerged through our discussions. First, we present two key reasons why more partnership research is needed in order to meet the challenge of establishing high-quality, equitable use of technology in urban schools. Second, we review four characteristics that participants agreed were necessary to successful partnerships between researchers and practitioners. Third, we present two additional issues that need to be addressed to create a better context for ensuring that this type of research has a broad impact on other schools and districts.

Why Does Educational Technology Need Partnership Research?

To address the problem of transferability of models and best practices. The National Science Foundation, the U.S. Department of Education, and many other prominent funders of technology and school reform work have invested heavily in efforts to bring identified best practices to scale. While isolated success stories appear, the challenge remains essentially unsolved, with models that are well established and clearly successful in some places failing to take root over the long term in a broad base of schools. Why is it so hard for success in one school or district to influence actions and decisions taken in other schools and districts? We know that a large part of the challenge is striking an appropriate balance between the core qualities of the innovation and the local needs, priorities, and interests of sites new to the innovation.

A great deal of funding has been devoted to bringing technology-based innovations to scale through recruitment, trainings, partnerships with other initiatives, and similar strategies. Some funders, however, have been supporting more grassroots, bottom-up, collaborative approaches to transfer and translation.

For example, the Joyce Foundation is supporting the Administrators' Reform Community (ARC). ARC comprises senior school personnel in the areas of curriculum and technology from five urban districts: Chicago, Cleveland, Detroit, Milwaukee, and Union City, New Jersey. Together, with partners from the University of Michigan and Northwestern University, ARC participants work to develop a collaborative infrastructure to support their own and each other's agendas with respect to the use of technology to support improved teaching and learning. ARC was created in recognition of the many ways in which technology challenges current school administrative structures. Using technology successfully in schools requires broad expertise, which means crossing many traditional "boundaries" in school organizations. For example, in many large districts responsibility for managing computer networks is given to management and information services units, which are traditionally responsible to the business side of school operations. Classroom use of technology, however, is frequently motivated by district curriculum organizations as part of instructional reform. Problems arise when a school's business and curriculum units have differing priorities and agendas. ARC provides school leaders with opportunities to uncover these potential problems and tap the expertise of their peers and colleagues across districts to share solutions. ARC participants visit one another's districts to learn about promising practices with technology, and meet in workshops to devise plans for monitoring and evaluating progress toward goals. The ultimate goal of ARC is the establishment of a self-sustaining community of urban school administrators who can turn to one another as peers to continue to push the state of technology use in their districts.

Another effort, funded by the National Science Foundation, is supporting a collaboration among the Center for Children and Technology, the Union City, New Jersey, schools, the Center for Highly Interactive Computing in Education (hi-ce) at the University of Michigan, and the Detroit public schools to explore how innovative and effective models of technology-anchored teaching and learn-

ing can transfer across contexts and how teachers, administrators, and researchers can collaborate to support, sustain, and gain knowledge from such endeavors. These efforts represent the early stages of practical test bed experimentation around the issues of transferability and localization.

To improve the fit between research practices and real school conditions. For several reasons, traditionally conducted and disseminated research-based knowledge is rarely a useful guide or source of insight for practicing educators (Norris, Smolka, & Soloway, 1999). Traditional academic research has not been responsive to the needs of school personnel. Much educational research lacks ecological validity (Cole, 1997), meaning that the research has not been conducted in settings and under circumstances that reflect the actual conditions in which practitioners work and where innovations need to take root. Further, much of this work focuses exclusively on outcomes and does not adequately describe the processes that contribute to the success or failure of an innovation. University-based researchers with a genuine investment in making their research useful to concrete processes of school reform are at a disadvantage. Their professional culture discourages service in favor of publication; academic researchers are expected to “specialize” and narrowly focus their domain of expertise; their primary audience is the academic community whose work appears in peer-reviewed journals and at conferences, where the goal is to advance theoretical rather than applied knowledge.

There is, however, a small but growing community of researchers who feel strongly that academic and applied knowledge do not have to be at odds. Researchers such as Schoenfeld (1995), Brown (1994), Cochran-Smith and Lytle (1990), Cohen and Barnes (1999), and Lagemann (2000) have long advocated for more synergy between research and practice communities. Our discussions about partnership research were grounded squarely in this kind of synergistic undertaking. Effective research must generate information that is useful to both the research and practice communities.

In a recent article entitled “Looking toward the 21st Century,” Alan Schoenfeld makes two points that are directly relevant to this discussion of partnership research:

- It is possible to conceptualize educational research in such a way that “pure” and “applied” work are not in conflict, but so that contributions to basic knowledge as well as practice can be seen as compatible and potentially synergistic dimensions of our work.
- Educational research has evolved to the point where it is possible, much of the time, to conduct research in contexts that are of practical import, working on problems whose solutions help make things better and contribute to theoretical understandings (Schoenfeld, 1999, p.5).

How, then, can new knowledge be produced, knowledge that is both locally useful and informative to a larger public interested in technology and school change? How can researchers invested in real school change and educators seeking new perspectives, resources, and partnerships to support their work produce new knowledge together? Making this happen requires shifting from a researcher/educator relationship of “expert and novice” to one of collaboration, in which ques-

tions, methods, and interpretations are co-constructed by peers with diverse but equally important areas of expertise. This change in perspective is essential to privileging the knowledge and expertise that reside within schools. This shift creates new expectations of school personnel, both teachers and administrators, and requires researchers to change how they listen, how they frame their work, and how they understand the goals of the research process.

What Makes for a Successful Partnership Research?

After discussing why partnership research is necessary to address the challenges of technology use in urban school reform, we began to articulate specific qualities of successful partnership research. Partners need to:

- **Establish a shared vision of the purpose and structure of the research process.** In any given collaboration, researchers and practitioners will have different but ultimately complementary goals. Researchers are primarily invested in establishing new knowledge, while practitioners are primarily seeking to improve their own practice and the resources with which they do their work. Understanding these differences and their mutual dependence is at the heart of building productive partnership research projects. Naming these differences explicitly and addressing them by adapting the focus and methods of the research process is what makes partnership research different from traditional academic research conducted in “naturalistic” settings. Traditional academic, empirical social science research is at base oriented to the creation of new knowledge and a one-way distribution of knowledge from the academy out into the world. Partnership research was described by participants as “use-driven”; that is, the needs of the school partners play a central role in driving the identification of problems, questions, and methods, as well as the interpretation of findings.

The key collaborators need to set and agree on the terms of partnership research projects from the beginning: Who will benefit from a given intervention? Who will have an opportunity to learn from, critique, or appropriate the intervention?

- **Establish trust among all participants in the partnership research process.** The model of evolving academic knowledge is still very much one of importing knowledge and expertise to the school community. Rarely do we take seriously the validity and embedded value of evolving knowledge and expertise in collaboration with the school community, yet this process is crucial to the building of effective partnerships. Participants agreed that only by creating relationships in which research and practice complement each other — in which knowledge is increased and practice is changed, and both influence the other — will we be able to bring best practices to scale in ways that work for local schools.

To scale up effectively requires genuine trust among the collaborating parties. Establishing trust takes time. It requires that processes be established that can genuinely support dialogue and conversation and multiple points of view. And it requires understanding, naming, and learning how to work with the institutional constraints that both researchers and practitioners

live with. Building genuine understanding of each other's institutional cultures is critical to establishing trust.

- **Establish broad ownership of the challenges being addressed.** Partnership research conducted in isolation, with only a small group of participating practitioners and researchers invested in the work, is unlikely to have either sustained impact within a district or broad recognition by other researchers or school communities. Partners who are seeking to have their research efforts contribute to larger change processes within districts need to identify and seek out decision-makers and leaders within the district and the local community. These individuals need to be integral to the partnership and to contribute to ongoing conversations about ensuring that the research process feeds into productive reform efforts within the district. This process can be complex because schools face multiple, often conflicting accountability pressures, so not every member of a growing partnership may emphasize the same goals or set the same priorities.
- **Plan for and invest in long-term research relationships that define and tackle a few problems deeply.** The most effective collaborations involve sustained focus on well-defined problem areas and long-term commitments between practitioners and researchers. Rather than asking schools to engage with a topic of interest to a research team, partnership research addresses instructional challenges that grow out of areas that practitioners identify as high priority. Following through on these areas of focus allows the researcher to follow the genesis of a process of reform, and allows practitioners to experiment, modify, and eventually institutionalize new practices that can help them address the challenges they identified as most important at the outset.

Creating a Context for Partnership Research

During our meeting, two other major themes arose that indicate qualities of a funding and dissemination infrastructure that need to be in place in order for partnership work to be successful and sustained over time. These themes were *alignment* and *dissemination*.

Alignment

This term denotes greater coherence and consistency among several components of the research, development, and advocacy work. Regarding school reform, alignment includes the need for better coordination of funding initiatives across institutions; congruence of research tools and definitions across research institutions; consistency of some forms of assessment across school sites; and compatibility of grant-based work within school districts. Fragmentation and duplication is prevalent in the work of all of these groups, and we discussed the importance of establishing more rigorous, coherent frameworks for conducting, disseminating, and supporting this domain of work.

The participants identified multiple historical roots to the lack of alignment in these various areas: the local governance of school systems; the tension between the privileging of individual research

specialties in academia and the need for common frameworks and scalable programs in the reform community; and the weak dissemination infrastructure in both the education and education research communities. All contribute to the sense, shared by many in this group, that we are all “reinventing the wheel” much too often. The need for greater alignment in these various areas is not a cure-all, because no one research process, mode of reporting, or funding stream will be adequate to the range of work that needs to be done. Greater alignment of resources and information, however, can help provide a stronger, more coherent base from which to carry out more localized and specialized work.

Dissemination

Few existing dissemination vehicles speak both broadly and effectively to the range of stakeholders who participated at this meeting. How can communication among educators, researchers, policymakers, and advocates be improved? More specifically, in this domain where we are seeking to combine new research processes and methods, shifts in classroom practices, and assessment practices, what forms of dissemination will move us beyond the distribution of outcome reports from isolated projects and studies?

Participants had few answers to these questions but shared a strong conviction that more and better dissemination — and the creation of new vehicles for dissemination — is an important piece of the puzzle. A particularly important challenge, we felt, was finding ways to share processes across schools and among researchers. How can practitioner/research groups in one location benefit from the experiences of groups working in distant school districts? How can incomplete, imperfect processes be shared in ways that don’t threaten or put at risk the work they represent? How can practitioners gain access to more than “picture postcards” of ideal projects unfolding in distant, ideal schools? What kinds of dissemination products can effectively convey the difficulties and the long-term process that schools invest in substantial change processes?

The work implied by all these questions will necessarily lead to a fundamental shift in school/university relationships, which in the end will improve both domains.

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For more than four decades, the Education Development Center, Inc., has been

bridging the worlds of research, policy, and practice. EDC's work is focused in multiple areas including early child development, K-12 education, health promotion, workforce preparation, community development, learning technologies, literacy, institutional reform, and social justice.

Since 1980, EDC's Center for Children and Technology (CCT) has been at the forefront of educational technology research and development. CCT seeks to foster learning and improve teaching through the development and thoughtful implementation of new technologies in a wide range of educational settings. CCT's work is centered in three areas: research, including basic, formative, and program evaluation; design and development of innovative technology prototypes and products; and the implementation of large-scale technology integration efforts.

CCT works in collaboration with schools, libraries, universities, community-based organizations, museums and arts organizations, publishers, and professional education associations, as well as corporate, private, and federal philanthropies. Across all our work, CCT seeks to understand and address the roles that diversity (e.g., gender, culture, and socioeconomic need) plays in shaping people's uses of technology. The mission of the center is twofold:

- To investigate the roles technology does and can play in children's lives in general and the classroom in particular.
- To design and develop technology applications that support engaged, active learning.

Based in New York City, the Center's staff of 45 is made up of former teachers, technology and curriculum designers, producers and programmers, developmental psychologists, anthropologists, and sociologists.

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