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Part I

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System-Wide Reform in Science: The Impact of District and School Context

Part I

Eric J. Osthoff, Vansa Shewakramani, and Kimberle Kelly

In this paper, we explore how district and school contexts affect the implementation and success of curriculum reform by shaping the allocation and use of organizational resources. Specifically, we examine science reform undertaken in the Los Angeles Unified School District (LAUSD) with the ultimate goal of fostering teaching and learning for understanding through extended, inquiry-based science curriculum units for Grade 4 and 5 students. Extensive teacher professional development for unit implementation and inquiry science teaching and learning was central to the reform initiative. This paper represents one of four interrelated studies being conducted by an interdisciplinary research team from the University of Wisconsin–Madison (UW–Madison), California State University, Dominguez Hills, and LAUSD as part of a project titled System-Wide Change: An Experimental Study of Teacher Development and Student Achievement in Elementary Science. This project builds in part on earlier work in LAUSD by the National Science Foundation (NSF)–funded Math and Science Partnership (MSP) project System-wide Change for All Learners and Educators (SCALE).[1]

Central to the System-Wide Change study is a cluster randomized trial designed to provide an unbiased assessment of the effects of the professional development intervention on student achievement (Borman, Gamoran, & Bowden, 2009). However, the cluster randomized trial cannot by itself illuminate the potentially complex path from intervention to outcomes. Hence, the project has undertaken three supplemental studies to better understand the *mechanisms* by which reform activities may exert observed effects on student achievement, studies that are ongoing at the time of this writing.

One supplemental study (Lal & Osisioma, 2009) is using classroom observations to document and compare the quality of implementation of instructional content and pedagogy in treatment and comparison schools. A second supplemental study (Bruch, Grigg, & Hanselman, 2009) is using teacher survey data from treatment and comparison schools to evaluate the organizational capacity of schools to support teaching for understanding and the effects of the intervention on teacher retention.

The third supplemental study, discussed here, utilizes data from interviews with actors throughout the system (from central office administrators to classroom teachers) to explore the range of policies and organizational practices perceived to support or impede reform. To focus our inquiry into the dynamics of reform as experienced by multiple role groups in a complex organizational environment, we proceed from a conceptual framework developed by Gamoran et al. (2003). As discussed in the Conceptual Framework section, Gamoran et al. propose the following taxonomy of organizational resources:

- *Material resources:* Money and the things money buys

[1] See the Math and Science Partnership Context section.

- *Human resources:* Attributes of individual educators, such as their professional knowledge, skills, and commitments to teaching practices

- *Social resources:* Attributes of networks of educators, such as roles, relationships, and communication dynamics

The ultimate substantive question guiding our study is:

How do district and school contexts shape the allocation and coordination of material, human, and social resources in such a way as to foster or impede the capacity of teachers and administrators to implement reform goals and vision?

We will report on this third supplemental study in two parts. In this paper, Part I, we focus on the district and school context and policies that shaped resource allocation for reform. In Part II, we will delve more deeply into the perceptions of teachers, science instructional support staff, and administrators about reform supports and barriers.

Although systematic analysis of the experiences of reform participants is valuable in its own right, getting full value from the present study depends on how its insights and findings inform and extend the other two supplemental studies and help account for the results of the cluster randomized trial. By triangulating findings from the full set of studies, we hope ultimately to identify and understand the mechanisms and processes of reform.

Below, we begin with an overview of the intervention, followed by discussion of the conceptual framework of the study. Next, we describe the study sample, instruments, methods, data, and analysis. We then present our findings on (a) the organizational context of the reform effort, (b) the reform as intended by the designers and implementers, and (c) the reform as actually enacted, including how and to what effect organizational resources available to the reform were used. We conclude with a summary of the study findings and policy implications.

Overview of the Intervention

Labor-intensive professional development (PD) was at the center of the LAUSD science reform initiative. The PD consisted of a week-long summer institute, two follow-up sessions during the school year, and ongoing mentoring. Due to limited resources and constraints on organizational capacity, the reform-oriented PD could not be implemented in all 400 LAUSD elementary schools simultaneously. Consequently, district leaders nominated 190 schools, and 80 were randomly selected for participation (10 schools in each of the eight LAUSD “local districts”). From the 80 schools, 40 were randomly assigned to the treatment group, and 40 served as controls (again, stratified by local district).

Within the treatment group, PD activities were offered to Grade 4 teachers beginning in 2006–07 and to Grade 5 teachers beginning in 2007–08. Each school was strongly encouraged to send two teachers to each of the Grade 4 and Grade 5 PD institutes—specifically, the school’s science lead teacher for the grade level and a grade-level colleague of the school’s choosing.

Also reflecting constraints in resources and organizational capacity, rollout of the Grade 4 and Grade 5 PD institutes occurred in phases. The Grade 4 institutes—featuring *Rot It Right* (SCALE, 2006), a life science "immersion" unit[2] in which students investigate decomposition to better understand the flow of energy through food webs—began in the summer of 2006 and was repeated in summer of 2007. The Grade 5 institutes—featuring *Weather: Forces and Prediction* (SCALE, 2008), an immersion unit in which students investigate weather patterns in the United States generally and southern California specifically—was conducted in the summer of 2007.

Conceptual Framework

As noted, our study draws on the dynamic model of organizational support developed by Gamoran et al. (2003). This model addresses the issue of how districts overall and teachers individually respond to challenges while moving toward implementation of teaching for understanding in math and science. Teaching for understanding is viewed as occurring through the formation of classroom groups that engage all students in meaningful work and are rich in resources that facilitate learning for understanding. As noted earlier, Gamoran et al. distinguished three kinds of resources—material, human, and social. When used effectively, these resources can aid in transforming groups into communities by helping to create a sustainable environment for organizational practice characterized by the reform vision of teaching and learning.

Gamoran et al. identified three key challenges to teaching for understanding: (a) providing adequate teacher resources, (b) aligning commitments and goals, and (c) sustaining the realized change. Given the fact (discussed below) that resources both enable and constrain reform efforts, using access to and transformation of resources as our conceptual framework allows us to address each of these challenges in our discussion of implementation of a system-wide elementary science reform in LAUSD.

Material, Human, and Social Resources

Material resources are the "things" teachers need in order to teach—for example, money, anything money can buy, physical infrastructure, curriculum, and electronic information. Such resources are tangible and can be exchanged among groups. Material resources may facilitate the reproduction of human and social resources and increase district capacity for change.

Human resources are the knowledge, skills, and commitments of educators (e.g., content knowledge, pedagogical ideas or practices, cultural or social understanding of students, beliefs about learning). Human resources are properties of individuals that can subsequently become properties of the groups in which the individuals hold membership; however, human resources need to be purposefully employed to begin the process of turning human resources into social resources.

[2] The science immersion approach, described in more detail in the Immersion Units section, essentially involves standards-based, inquiry-oriented units requiring daily lessons for up to 6–8 weeks or more for full implementation.

Social resources are the attributes of roles, relationships, and communication (e.g., norms, information flow, common purpose) that are embedded in social networks. They may be built from material or human resources. However, unlike material and human resources, social resources may not be exchanged between groups but must be constituted anew within each group. Consequently, social resources are a good indicator of the extent to which individuals have successfully performed the social labor necessary to transform themselves from a group into a community. Given that human resources, supported by material resources, are the basis for social resources, a conceptual framework that helps track resource allocation and use can reveal the degree to which initially individual resources become communal and by what means.

Groups, Professional Communities, and the Creation and (Re)allocation of Resources

Groups are defined as any number of individuals who share activities through direct, personal interaction. Groups can potentially be transformed into *communities* that also share norms, language, and values. In strong communities of practice, group activities tend to reproduce existing resources as well as create new ones. For example, PD time, a material resource, can foster professional knowledge, a human resource. Once all members of a group have shared professional knowledge (e.g., a similar understanding of inquiry pedagogy), it becomes possible, though not inevitable, for group members to form a shared commitment to that knowledge or practice, a social resource. In this way, organizational resources are central to the processes by which actors reproduce existing practices or expand organizational capacity for system-wide reform. Understanding how actors use resources can help elucidate the processes by which groups succeed or falter in becoming professional communities of practice.

The transformation of groups into communities is not a linear process, in part because resources can be constraining as well as enabling. Indeed, the same resource that has the intended primary effect may have secondary consequences that are both unintended and undesirable. Assessments and accountability policies are good examples of resources that can cut both ways. Emphasizing accountability for assessment performance can have the undesired effect of overemphasizing memorization-based and procedural knowledge at the expense of conceptual understanding even while succeeding in raising the priority given to subjects that are among those used for accountability.

Autonomy is another example of a resource which both enables and constrains. In LAUSD, elementary teachers have considerable autonomy in deciding how much science is taught and when. Because principals do not know exactly when science will be taught, they are less likely to observe and thereby learn what they might do to further support instruction. In this way, teacher autonomy discourages a type of interaction by which groups become communities of practice.

Figure 1 helps convey the central role we assign to material, human, and social resources in the dynamic, nonlinear interplay of groups, practices, and communities in organizational contexts. The transformation of groups into professional communities is of special interest because professional communities are hypothesized to be a particularly effective vehicle for changing grounded practice to reflect reform vision and goals. As implied in Figure 1, teaching and learning are organizational practices that take place in and are thus enabled and constrained by the broader contexts of the schools, districts, and communities in which teachers and their students are situated.[3]

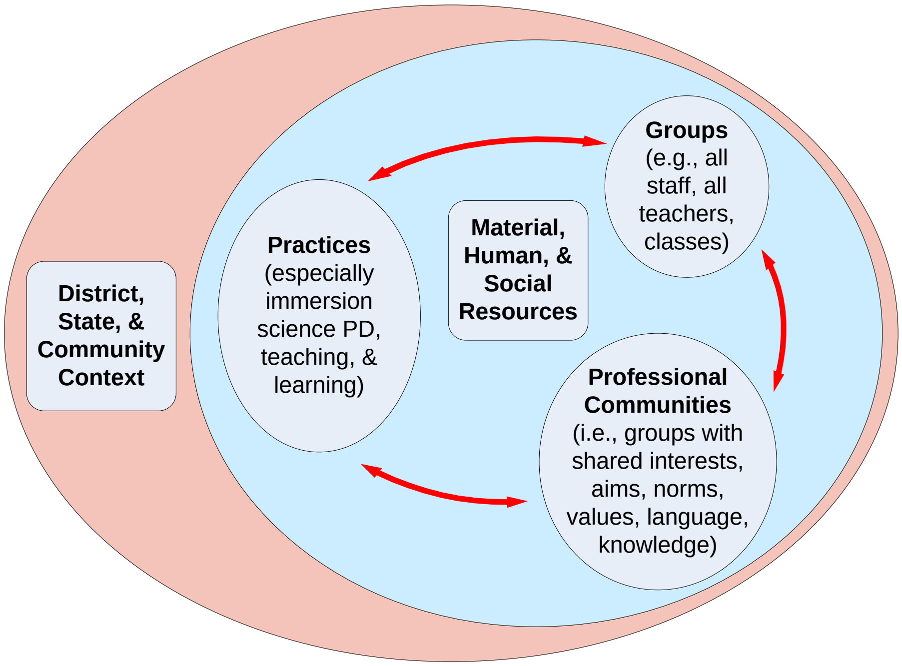

***Figure 1*. Relationship of resources to groups, communities, and practices in organizational contexts.**

Since we define a group as "a collection of individuals who share activities that involve direct personal interaction" (Gamoran et al., 2003, p. 25), every school actor is a member of one or more groups. As Halverson (2004) noted, school actors never work in a vacuum, but enter into ongoing environments already populated with policy and resource arrays. In contexts where reform is undertaken, at least some actors (typically in the district or state of which the school is part) endeavor to purposefully change certain practices. We posit that reformers' theories of change, however tacit, typically involve either reallocating existing organizational resources or creating and directing the dissemination of new organizational resources, or both, to foster reform practices.

Implications for the Present Study

Reallocation strategies can have great impact when the resources needed to support reform are already present but not effectively targeted. For example, in the present study, LAUSD policy provided schools with substantial planning and on-site PD time each week, but these resources were largely dedicated to English/language arts and math, not science. Allocating some of the available school planning time to science PD and instructional planning represented a potentially effective strategy for giving teachers opportunities to share the human resources

[3] Figure 1 draws conceptually on Gamoran et al. (2003).

(e.g., knowledge of and commitment to immersion teaching and learning) needed to enact instructional practices envisioned in the reform. However, access to such planning time was much impeded by a commitment at the district, state, and national level to the primacy of English/language arts and math in the elementary grades.

Furthermore, merely setting aside time to address science would not have been sufficient in schools where teachers or administrators lacked the human resources to engage in immersion teaching and instructional support. Similarly, more science planning time would have been ineffective if such actors lacked the social resources (e.g., shared sense of purpose, clearly and appropriately defined roles and relationships, or productive communication dynamics) needed to foster the transfer of human resources from the few who possessed them to those who did not. Increasing the access of all group members to critical human resources is integral to creating robust professional communities in which actors have shared interests, aims, norms, values, language, and knowledge.

The preceding discussion foreshadows our ultimate analytic aim: understanding the complexity and dynamism of school organizations and thus the array of material, human, and social resources to which reformers and leaders may need to attend in order to influence organizational practices such as teaching for conceptual understanding. Before continuing with this analysis, we describe the study, the district context, and the intended reform effort in greater detail.

Study Design and Methods

Sample

As observed by Fullan (2001), the positions or roles occupied by actors in school and district organizations greatly affect their perspectives on the construction of meaning in daily organizational life. This is partly because actors engaged in different organizational tasks experience differential access to relevant information and resources in the course of daily practice. Recognizing this fact, we developed a series of interview protocols to explore various actors' perceptions of the intended and actual elementary science reform under study.

The first round of interviews, conducted in April, May, and June of 2008, asked actors to reflect on experiences related to Grade 4 and 5 science, especially the rollout of the Grade 4 immersion PD institutes in the summer of 2006. We conducted first-round interviews with:

- Four central office administrators for elementary science;
- Four local district administrators of instruction (responsible for oversight of instruction in all subject areas for all schools in the local district);
- Seven local district elementary science experts (subject-area specialists with responsibility for disseminating and supporting the district elementary science program in all schools in the local district);
- Thirteen school principals; and

- Twelve Grade 4 science lead teachers (SLTs).

For principals and SLTs, only treatment schools were sampled. The sampling strategy was to select one SLT who was trained and one who was not in each local district, plus their respective principals. When possible, we optimized the likelihood of interview participation by choosing SLTs who had cooperated with observations.

A second round of interviews was conducted in May and June 2009. We will report on these later interviews in Part II of this paper.

Protocol Design and Development

We designed the semistructured interviews to elicit respondents' experiences with and perceptions about:

1. The goals and vision of the elementary science reform;
2. The nature, distribution, and use of available organizational resources to support reform implementation;
3. Impediments to desired change, including district, state, and school policies or contextual factors;
4. The alignment of targeted instructional reform with other state and district policies and instructional priorities;
5. The breadth and quality of the PD intervention;
6. The effects of PD participation on the breadth and quality of classroom implementation of immersion units; and
7. The success and sustainability of science immersion teaching and learning.

The selection of these interview topics reflected in part our decision to use the Gamoran et al. (2003) conceptual framework to guide inquiry and analysis.

Data Collection

As noted above, data analyzed for this paper were collected in April, May, and June of 2008. By that time, the reform had been in place for long enough (nearly 2 years) to allow participants to reflect on their own experiences as well as their observations of the diffusion of the reform across the district. Two UW–Madison researchers conducted LAUSD central and local district office interviews, while LAUSD research and evaluation staff conducted principal and teacher interviews.

Data Management

All interviews were audio-recorded, transcribed, and coded. Intensive coding was done by two UW–Madison researchers working closely with one another to ensure consistent application of codes. This process involved independent coding followed by comparison of results from sample interviews within each role group for purposes of calibration. Coders also conferred periodically with the larger project team to ensure that findings could be effectively triangulated across interview, survey, and classroom observation data sets.

To date, the analysis has relied on manual sorting of data into a large table displaying the intersection of resource-type codes with the intended and actual intervention, by interviewee, role group, and school. The quality of the interview data is very good for the central and local district staff but uneven for the principals and SLTs. In part, the unevenness of the principal and SLT interview data reflects the inevitable unevenness in interviewers' skill in eliciting detailed data. However, the quality of these interviews fluctuated even for relatively proficient interviewers. Often, this was due to the respondent's having less time than desired and interviewers' compensating by accepting brief answers without follow-up.

Findings

Organizational Context of the Reform

Volumes could be written about contextual factors that potentially influence teaching and learning reform efforts in any large urban district. To focus the discussion here, we direct our attention (with one noted exception)[4] to factors identified by interviewees. In general, interviewees situated the broader reform effort at the intersection of the district, the state, and the SCALE MSP.

District Context

The sheer size of LAUSD—the second largest school district in the nation—makes organizational complexity and fragmentation practically unavoidable. Even organizational veterans report there is still much they do not know about district scope and operations. Indicators related below hint at the size and complexity of the district.

K–12 enrollment in LAUSD for SY 2008–09 was reported at 688,138.[5] If LAUSD were a state, it would be in the middle of the pack in terms of K–12 public school enrollment. Approximately 72% of all students are Hispanic, 11% Black (not Hispanic), and 9% White; 8% belong to other racial groups. In SY 2007–08, more than 240,000 LAUSD students were English language learners, including nearly 226,000 native Spanish speakers, and approximately 14,000 students were drawn from 54 other language groups. Eligibility for free or reduced-price lunch is at 68%.

[4] The exception is our discussion of LAUSD's history of vacillation between centralization and decentralization. See *District administrative structure* in the District Context section.

[5] District demographic statistics reported here are from the LAUSD website (LAUSD, 2009).

LAUSD students are served in 885 K–12 schools by approximately 77,300 regular employees, including nearly 37,000 teachers and approximately 2,800 administrators. Grades 4 and 5—the two grades included in this study—together enroll approximately 108,000 students, taught by nearly 3,900 teachers. In 2004, when SCALE activity in the district had gotten into full swing, the annual operating budget for LAUSD was $5.7 billion dollars.

District administrative structure. For at least the last 2 decades, LAUSD has vacillated between centralization and decentralization.[6] For example, in 2000 then Interim Superintendent Ray Cortines spearheaded a move to increase organizational performance and community responsiveness by dividing the district into 11 geographically based, semiautonomous administrative units, now called local districts. This district restructuring involved the transfer of a large proportion of instructional support positions and administrative authority from LAUSD central to the new local district superintendents.

Former Colorado Governor and National Governors Association Chair Roy Romer assumed the LAUSD superintendency in 2000, following Cortines. Reflecting a systemic reform perspective, Romer's model for organizational improvement called for greater central office leadership and control, especially over instructional guidance. Romer reduced the number of local districts from 11 to 8, redirecting some of the saved overhead to bolstering central office capacity for instructional guidance and support. English/language arts and reading were the first areas targeted for improvement, with math following and science receiving little attention until SCALE was under way in 2002.

District theory of change. An early move by Romer to bring the LAUSD central office back to the center of instructional guidance was to have the district join the Institute for Learning (IFL), a network of school districts operating under a shared theory of change to improve standards-based teaching and learning.[7] The IFL theory of change later became part of the vision for LAUSD science reform during SCALE. Briefly stated, the IFL theory of change, as adapted to SCALE, sought coherence in instructional guidance through well-aligned policies and supports in five "dimensions":

1. *Teaching dimension.* In the teaching dimension, the ideal policy instrument to guide instruction is a "designed curriculum," defined by Resnick (2004) as "one built to careful specification, usually theory-based, tested in use, and usually crafted to fit in time actually available for instruction" (p. 6).

2. *Professional learning dimension.* The professional learning dimension includes PD focused on rigorous, standards-based student learning for role groups at all levels of the organizational hierarchy. For teachers, this includes intensive, ongoing PD and coaching on

[6] The recent history of LAUSD decentralization and recentralization was little discussed in interviews for this study but is included here to provide context for later discussion of interviewees' observations about the practical effects of administrative structure on reform. This historical background is based on document review and district interviews conducted by one of the researchers, who has been involved in field studies in LAUSD since 2003 as a member of the SCALE Research and Evaluation Team.

[7] For further discussion of the IFL theory of change for instructional improvement in urban districts, see Glennan and Resnick (2004).

instructional strategies that require extensive pedagogical content knowledge. For administrators, it means PD on how best to support desired teaching and learning by interacting with teachers or becoming part of a learning community that includes instructional support staff so as to foster common vision, goals, and support strategies.

3. *Monitoring dimension.* The monitoring dimension includes assessments, especially formative assessments that can be used to inform teacher instructional decision making.

4. *Accountability dimension.* The accountability dimension includes high-stakes assessments and associated sanctions or rewards for performance.

5. *System dimension.* The system dimension refers to the coherence of the full range of instructional guidance policies and practices and the alignment of these with the vision of rigorous, standards-based teaching and learning. Coherence across dimensions is seen as fostered by the integration of role groups into a broader professional learning community, characterized by a shared vision and professional practices that honor the vision.

The IFL theory of change was an important source of vision for the SCALE LAUSD science work at the outset. However, as discussed in the Math and Science Partnership Context section, differences over strategy emerged within the SCALE partnership, and this contributed to multiple competing change strategies for LAUSD science.

District capacity for science instructional support. A crucial aspect of LAUSD capacity to support science instruction during the reform under study has been its cadre of science experts. Core responsibilities of these science experts include distributing instructional materials, designing and delivering PD, providing technical assistance and coaching to teachers, and keeping principals informed about district science activities.

Science experts in LAUSD are housed in local district offices and primarily support science instruction for local district teachers and schools. For several years, local districts have had at least one science expert each for elementary and secondary levels. Coordination and consistency across local district experts has been fostered through semimonthly meetings of elementary and secondary district science teams. The elementary district science team included local district elementary experts and central office science administrators and staff. During SCALE, a UW–Madison science immersion team leader joined each district science team to help with science planning and support, especially developing immersion units aligned to district standards and related PD tailored to LAUSD's context and needs.

District turnover. Like many other urban school districts, LAUSD experiences high turnover at all levels, which undermines the sustainability of reform. LAUSD has had four superintendents since 2000, including three during SCALE.[8] Turnover is also very high in senior central and local district administrative positions. Much of the turnover in central and local district positions consists of the shuffling of existing administrators rather than new hires.

[8] At more than 5 years, Roy Romer's term as superintendent was exceptionally long. Romer's term included the first 3½ years of SCALE and thus provided relative consistency in district science policy and reform strategy during that period.

However, even shuffling can disrupt reform as it takes time for new appointees to get their bearings—and once they have, they may elect to change course or strategy, requiring additional retooling among affected support staff.

LAUSD has also had high teacher turnover. In SY 2003–04, more than 28% of all LAUSD teachers were in their 1st or 2nd year of teaching. A large and steady flow of new teachers into the district creates a serious dilemma for PD strategic planning. It is difficult to reach all teachers with PD for instructional innovation if one-quarter of the teachers trained in Year 1 of an initiative are gone at Year 3. Such turnover requires use of limited funds to repeat the same PD sessions year after year. The more the organization's PD resources and capacity are dedicated to standing PD sessions, the less there is available to design and deliver more advanced PD for veteran teachers who have already participated in basic PD.

One bright spot in support for elementary science reform in LAUSD in recent years has been the low turnover among elementary science experts. This has fostered continuity and steady growth in science experts' capacity for reform, both individually and collectively. Having a shared history as participants, designers, and providers of reform-related PD has allowed them to achieve a level of professional community around teaching and learning rarely experienced by actors such as principals and teachers.

Math and Science Partnership Context

The SCALE MSP began in 2002, with an original NSF funding commitment of $36 million over 5 years. Initially, SCALE partners included four urban school districts—LAUSD; the Madison (Wisconsin) Metropolitan School District; Denver Public Schools; and Providence Public Schools—and four universities—UW–Madison; University of Pittsburgh; California State University, Dominguez Hills (CSUDH); and California State University, Northridge (CSUN). Reflecting the broad aims of the MSP program, SCALE identified various ways to unite the capacities of key role groups from each organization to promote standards-based instructional improvement.[9] Hence, the science reform initiative under study sought to address teacher preservice as well as in-service development through collaboration between university curriculum and PD designers and research and evaluation specialists; university science and science education faculty; K–12 administrators and instructional support specialists; and K–12 teachers. In addition to providing LAUSD with significant funds to intensify science PD, SCALE represented a potentially powerful tool to be utilized by Superintendent Romer to increase both the coherence and the salience of central office instructional guidance for science and math.

Cross-organizational collaboration was an especially important part of the LAUSD elementary science efforts. For example, led by the UW–Madison Immersion Design Team, all role groups collaborated in designing the science immersion units created by SCALE as a vehicle for fostering sustained inquiry in science teaching and learning. Similarly, all role groups collaborated in designing and refining the PD model used to introduce LAUSD teachers to the immersion materials and the distinctive immersion approach to inquiry science teaching and

[9] The LAUSD elementary science efforts were just one part of the broader SCALE initiative. SCALE conducted math as well as science reform at most if not all grade levels in all four partner districts.

learning. Further, institutes were co-facilitated by collaborative teams that included one or more LAUSD local district science experts, university scientists, and LAUSD classroom teachers. University PD experts and science education faculty also co-facilitated many institutes.

Lauffer and Lauffer (2009) have described how co-facilitator collaboration helped participants evolve into a professional learning community exemplified by characteristics such as shared goals, language, professional knowledge, and reflective dialogue.[10] More information about immersion units and PD is found in the Reform as Intended section. The main point here is to recognize that meaningful partnership collaboration across organizational boundaries and role groups occurred with respect to curriculum and PD design and delivery. This collaboration fostered the alignment of curricular materials with district content standards, ensured that immersion units and PD met scientists' criteria for accurate and important science content, and incorporated classroom teachers' ideas on adapting units and instructional strategies to students' learning needs and styles.

As noted above, the IFL theory of change was initially recognized by a range of university and district partners to be the guiding vision and strategy for SCALE science and math reform in LAUSD. However, differences arose among senior partnership management, especially those based in institutions of higher education. By the 3rd year of the partnership, the division of labor in LAUSD was such that IFL actors focused primarily on district math reform, and UW–Madison actors, in collaboration with science, technology, engineering, and mathematics (STEM) faculty from CSUDH and CSUN, became the major source of university support for LAUSD science reform. Efforts were further divided between elementary and secondary science. Then as now, the district had elementary and secondary science and other subjects under separate administrative lines. As SCALE science activities in LAUSD spread from the secondary to the elementary grades, a decision was made at UW–Madison to have one SCALE science lead focus on elementary science and the other on secondary.[11]

State Context

In discussing the influence of the state on elementary science reform, interviewees referred primarily to three factors: (a) the No Child Left Behind Act of 2001 (NCLB; 2002) and associated policies related to accountability for adequate yearly progress (AYP), (b) state science curriculum standards, and (c) state educational financing, especially state financial problems requiring LAUSD budget cuts.

Accountability. As illustrated in the Accountability Policies section, district actors at all levels saw AYP-related accountability as having far-reaching effects on educational priorities and practice across the spectrum of subjects. Although interviewees knew NCLB and AYP

[10] This evolution may have been somewhat less complete for actors involved in elementary immersion activities than for those in secondary activities. The work with secondary science got under way more than a year before the elementary component was added.

[11] Because of the division of labor between elementary and secondary science in LAUSD and SCALE, the implementation and effects of SCALE science reform in LAUSD differed by level in many important ways. The secondary science effort is beyond the scope of this paper but is being addressed in a work in progress by Osthoff and others.

originated with the federal government and provided states with only limited flexibility, their statements rarely referred explicitly to the federal context of the state accountability system.

State curriculum standards. Interviewees cited state standards as the primary basis for the district vision of important science content knowledge. Generally, interviewees treated state standards as a given and did not remark on their perceived pros and cons.

State financing. Interviewees recognized that district finances rose and fell with the larger state economy. They did not blame a problematic state education finance system, but they were painfully aware of how downturns in resources affected staffing and district capacity to support science PD and reform implementation.

Summary

The reform on which we report here took place in an environment in which the main constant was change itself. The district is a large, complex system with diverse students, high levels of organizational fragmentation, high turnover among administrators and staff, a state education agency conveying new accountability policies, and state and district budgets eroding during the initial years of the study and hit hard by the recent, even more severe, fiscal crisis. The early years primarily targeted by our interview data saw a district superintendent and district theory of change calling for renewed central office instructional guidance and the capacity to support it on the ground. These years also saw the launch of the SCALE MSP, which was designed to fit within the district theory of change while garnering increased funding and human resources to accelerate science reform for more equitable and higher student achievement, especially for conceptual understanding about scientific phenomena and processes of inquiry.

The Reform as Intended

The intervention in this study was designed to measure science achievement as a *product* of teacher PD and a content-rich inquiry curriculum. The 80 schools participating in the cluster randomized trial were randomly assigned to treatment (curriculum and PD) and comparison (curriculum only) groups. Thus, comparing student achievement in the two groups over 3 years enables us to discern the causal effect of adding PD in support of the immersion initiative.

Immersion Units

As noted earlier, the curricula for the intervention consist of immersion units, so called because they immerse teachers and students in the full cycle of science inquiry. The units are standards-based in three ways: First, the curricular content is aligned to state and district standards for science at the targeted grades—Grade 4 (*Rot It Right*; SCALE, 2006) and Grade 5 (*Weather: Forces and Prediction*; SCALE, 2008). Second, the instructional approach promoted in the immersion curriculum closely reflects the *National Science Education Standards* (National Research Council, 1996; Olson & Loucks-Horsley, 2000). Like those standards, the immersion curriculum emphasizes posing scientific questions, giving priority to evidence, connecting evidence-based explanations to scientific knowledge, and communicating and justifying explanations. It relies on inquiry methods to address core content and organizing principles of scientific understanding. Third, heeding the National Research Council's (1996) admonition to avoid disconnected hands-on tasks, SCALE immersion units were carefully designed to embed hands-on activities in a conceptual flow that helped students learn interrelated science concepts while progressing through the inquiry cycle.

Professional Development Institutes

The PD institutes constituted the other major element of the intervention as intended. As described earlier, PD activities were offered to Grade 4 teachers starting in 2006–07 and Grade 5 teachers starting in 2007–08. From each treatment school, a science lead teacher and a grade-level colleague were asked to participate. In line with current research on effective PD (e.g., Porter, Garet, Desimone, & Birman, 2003; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003), the institutes were designed to (a) provide opportunities for teachers to build their content knowledge; (b) model the strategies teachers would be using with their students; (c) facilitate the building of a learning community with collective participation of teachers from the same school, department, or grade; (d) support teachers to serve in leadership roles; (e) involve continuous assessment and improvement; (f) be characterized by active learning; (g) be coherent; and (h) be sustained over time.

The resulting Science Immersion Model for Professional Learning (SIMPL), which was adapted from work by Mumme and Seago (2002), created an explicit structure for engaging teachers in the immersion unit as both teachers and learners. Each day of the immersion institutes was divided into several sessions, with most focusing on a particular lesson in the larger unit. In a typical session, teachers engaged in the lesson first in the role of learner. This allowed teachers to personally experience the cognitive activities in which they would eventually seek to engage students. Participants were expected to hold comments and questions reflecting a teacher perspective until later in the session when the lesson would be deconstructed from that perspective.

To foster sustainability and capacity building, the institutes were originally designed to use a "train-the-trainer" model, offering PD to science lead teachers (SLTs), who would in turn be responsible for sharing the immersion unit and approach with colleagues in their respective schools with support from their local district expert. This is an example of human resources (attitudes and commitments to science teaching) being leveraged to create social resources (collaboration and a collective focus on student learning), thus helping to transform groups into professional communities. A second tier of training was originally planned for SLTs to develop their capacity to support dissemination of the immersion approach in their schools. However, Tier 2 immersion PD institutes never materialized, and the expectation that SLTs would formally train other teachers was eventually deleted from the position description.

The Reform as Enacted

The context for the LAUSD reform did not directly determine the material, human, and social resources brought to bear to advance elementary science reform. Rather, the context typically affected resource availability and allocation by shaping district policies, which in turn encouraged or constrained resources for science reform. Interviewees identified local policies in three areas as extensively affecting resource allocation and use for science reform: (a) district accountability policies, (b) district instructional priorities, and (c) district administrative structures. All role groups agreed overwhelmingly that state accountability policies shaped local instructional priorities by focusing accountability heavily on mathematics, reading, and English/language arts. Role groups were differentially attuned to the nature and effects of district administrative structures. Many central and local district administrators and support staff attributed reform implementation effects to administrative structures. Explicit linking of administrative structures to reform implementation was markedly less common in principal interviews and rare in teachers' remarks.

Accountability Policies

Perspectives from the interviews. Here, we offer examples of what we heard from all role groups about how local instructional priorities were shaped by state and federal accountability policies emphasizing mathematics and English/language arts (ELA), including reading.

A Grade 4 SLT spoke of the factors limiting the commitment to science:

> Some of my colleagues, because of the pressure being put on us by the state to raise test scores, feel that we don't have time for science. They believe, "The state is asking for math scores and reading scores, so that's where we should spend the bulk of our time." Therefore, they're kind of like turned off to teaching science. . . . I mean they still teach it; they do teach it, but it's a fight . . . because [there's] pressure coming from our principal and the pressure she's getting from her superintendent and that superintendent is getting from [the district] superintendent. You spend 2½ hours [a day] on reading, but you're only required to do 90 minutes a week of science.

One principal noted that concrete needs at the local district and school levels coincided with state and federal accountability policies giving priority to math and reading/ELA:[12]

> I: Compared to other subjects, how much priority do you think is given to science teaching at the central level and local district levels?
>
> R: Well, when you look at it from the local district perspective, [in] our elementary schools, the most identified need is English language learners . . . following that, math—being that it is harder—the state accountability, as well as the federal accountability, and then, science third, because it is part of the state accountability.
>
> I: And why would you say that as to why it's prioritized?
>
> R: I think it's prioritized based on need and also based on what has been the identified—how can I put it?—the state and federal government have determined . . . the areas that schools need to be accountable to. Obviously, those are the areas that we have to focus on to ensure that students succeed in those areas. If the state told us that pottery

[12] I = interviewer; R = respondent.

> would be the determining factor in school success, then we would have to focus on that. It is driven by state and federal mandates.

A second principal reported similar priorities, while being more explicit about the educational rationale for limiting science instruction when reading/ELA and math achievement are too low:

> I: Compared to other subjects, how much of a priority is given to science teaching and learning at the central and local district levels?
>
> R: I'd say it's probably fairly low on the totem pole because we have really been spending a lot of time on math, language arts, and ELD [English language development]. I know that at our principals' meetings, we don't really spend much time talking about science except when it's integrating it with the Open Court [the district elementary reading curriculum]. Just as with the local district and the [central] district, we've been spending a lot of time on math, language arts, ELD.
>
> I: And why do you think that is? Is that because it's what the district wants?
>
> R: It's what the students need. I know that they need the science, but if they don't know how to read, they can't write, and they can't do mathematics, they're not going to be successful in any other subject. So we're still spending time on that. When we start to feel that our language arts, our math, and our ELD are pretty solid, that's when we start to spend more time on science. I know that's not really ideal, but that's just the way it's been here.

A local district administrator of instruction likewise spoke to the priority accorded math and reading/ELA:

> I think science is very important, but I think right now what our district looks at, and how we are publicly recognized, more of a focus goes into literacy and mathematics. And although science . . . does count as part of the [California Standards Test], in AYP it's a small portion. And I don't think the public gives a lot of thought to science. And they are really looking at what is the literacy rate of our students, and the mathematics literacy of our students. . . . I have to say, even for me, I don't put a lot of energy into science because again, the literacy piece and mathematics literacy is so important in regards to the public . . . and we have many more resources [for math and literacy].

Insights from the interviews. Four insights can be gleaned from such discourse. First, powerful factors limited the extent to which actors at all levels emphasized science as compared with other core academic subjects such as ELA and math.

Second, actors saw federal and state accountability policies as a major factor in elevating math and reading/ELA to a higher priority than science. In particular, they pointed to NCLB rules that give greater weight to reading/ELA and math than science in determining whether schools and districts are making AYP. AYP status is the basis for NCLB sanctions and also figures into community perceptions of school and district performance.

Third, some actors believed reading/ELA and math were foundational to success in other subjects such as science. Hence, such actors believed it was educationally prudent to give more attention and resources to reading/ELA and math unless and until students showed proficiency in such "basic" subjects.

We have yet to examine the extent to which role groups across LAUSD perceived accountability policies to have more influence on instructional priorities than beliefs about the foundational status of math and reading/ELA knowledge and skills. For now, it is worth noting that the two factors may be mutually reinforcing. Furthermore, the belief that reading/ELA and math proficiency are prerequisites to academic success in general most likely preceded NCLB and would persist even if that legislation and federal and state accountability systems were to be discontinued altogether. An analytic implication of this is that interpretation of the attribution of organizational practices to policies in interview data is a dicey business; actors often recognize constellations of influential factors tacitly even when their discourse might seem to depict practice as flowing from a single overwhelmingly dominant cause.

Fourth—and perhaps more important—the same policies that prioritized reading/ELA and math over science also prioritized science over other subjects. For example, the teacher quoted above observed that people do in fact teach science and that a district policy called for 90 minutes of elementary science instruction per week. Similarly, the principal who affirmed a belief in the primacy of reading/ELA and math and the administrator of instruction who stated that she allocated little of her own effort to science indicated that they nonetheless ascribed substantial value to science as a subject. In fact, even as actors described the low status of science relative to reading/ELA and math, they indicated that science still had higher priority than social studies and history.

Interviewees cited other policies as reflecting or supporting at least moderate organizational commitment to science. For example, many noted that science as well as reading and math had been included when the district implemented a periodic assessment system. We heard mixed views about whether periodic assessments were meant to be used formatively by teachers for classroom instructional decision making or by administrators for school accountability purposes. Nonetheless, there was a strong district expectation that teachers would administer the periodic assessments, and the majority of teachers did so.

Similarly, interviewees believed that the addition of science to the annual state assessment regimen (Grade 5 in 2004 and Grade 8 in 2006) was meaningful even though science was not included with math, reading, and ELA as a basis for assessing AYP. Further, aspects of broader district support for elementary science, including expenditures on SLTs and the immersion institutes and units, were seen by many as evidence that the district had made a commitment—albeit a limited one—to science.

Local Instructional Priorities

Earlier, we asserted that change was the only constant in LAUSD. Data from our interviews show that changes in district instructional priorities initially favored and later diminished the prospects for the long-term sustainability of the immersion PD institutes and curricula as a district strategy for fostering standards-based, inquiry-oriented, science teaching and learning for conceptual understanding.

Early on, district priorities were favorable to the reform. With the launching of SCALE, immersion PD quickly became a major emphasis for LAUSD central and local district science instructional leaders and support staff, largely replacing the infrequently used textbooks and one-shot PD events that had previously been the mainstay of district instructional guidance for elementary science. This was particularly true in SY 2005–06, when the district offered 1- to 2-day immersion PD sessions to a large number of Grade 4 teachers to supplement the more extensive 5-day immersion PD institutes simultaneously being conducted by the larger partnership.

The shorter district PD sessions were intended to disseminate the immersion approach and curricula to teachers more rapidly than could be done through the intensive 5-day institutes, given available resources and PD capacity. These shorter sessions omitted time the 5-day institutes allocated to enhancing teacher science content knowledge. They also omitted university STEM faculty entirely, and often classroom teacher co-facilitators as well. Thus, the district's supplemental immersion PD was frequently delivered solely by local district science experts.

Some SCALE immersion leaders within institutions of higher education questioned whether the district's supplemental PD model had enough substance to foster sufficiently deep teacher understanding of and commitment to immersion. Set against this was the view of many district administrators that the science inquiry reform effort would never go to scale if it relied exclusively on the SCALE PD model with its emphasis on depth over breadth. Despite these differences over reform strategy, the district's commitment to immersion as a major focus of reform and its instructional support efforts remained high, and delivery of the main treatment under study continued.

Later, a change in district instructional priorities went against the long-term prospects for immersion science in LAUSD, as well as the prominence of the SCALE PD model. Specifically, just in time for the 2007–08 school year, the district central office announced a shift in its science reform strategy, adopting the Full Option Science System (FOSS) curriculum for all elementary grades throughout the district. The district continued to encourage teachers who wanted to implement immersion units to do so and continued to support SCALE-facilitated immersion institutes in the summer of 2008, permitting the completion of immersion PD institute delivery as specified in the original design of the System-Wide Change project's cluster randomized trial. But a range of actions taken by the district to support the FOSS rollout sent strong signals to teachers, principals, and local district administrators that FOSS would be at the heart of elementary science instruction going forward. For example, the district purchased a set of FOSS kits and related student curricular materials for each grade in every elementary school. Also, except for limited co-facilitation of immersion PD institutes by local district experts, the full capacity of LAUSD central to provide PD for elementary science was committed to FOSS. Deciding that the local district experts were too few to deliver 1- to 2-day FOSS PD sessions as quickly as desired, the district contracted out delivery to the company that publishes FOSS. Local district experts were charged with scheduling and monitoring the work. Though the district did not make FOSS PD mandatory for teachers, it did mandate that all elementary teachers use FOSS for classroom instruction.

One could argue that all along the goal of the district's elementary science reform had been to stimulate and support inquiry-based science generally and that the FOSS initiative represented only a different strategy for pursuing that goal. Indeed, central administrators said immersion and FOSS had much in common—that immersion represented a more student-directed inquiry approach whereas FOSS emphasized guided inquiry. However, data from the present study indicate that the adoption of FOSS represented a constraint on the reform activities at the heart of the System-Wide Change study. The data show that FOSS became the primary concern of SLTs, principals, local district experts, and district administrators beginning in SY 2007–08, and thereafter far fewer resources were allocated to support immersion PD and curricula.

Local Administrative Structures

The third and final aspect of district policy of special consequence to resource allocation and use was embodied in district administrative structures and lines of authority. Figure 2 presents a very simplified version of the administrative structure for role groups that were most involved in the elementary science reform work. Successful science reform depends heavily on coordination among the actors involved, but the figure highlights several ways in which lines of authority were missing or highly convoluted among certain role groups in the district.

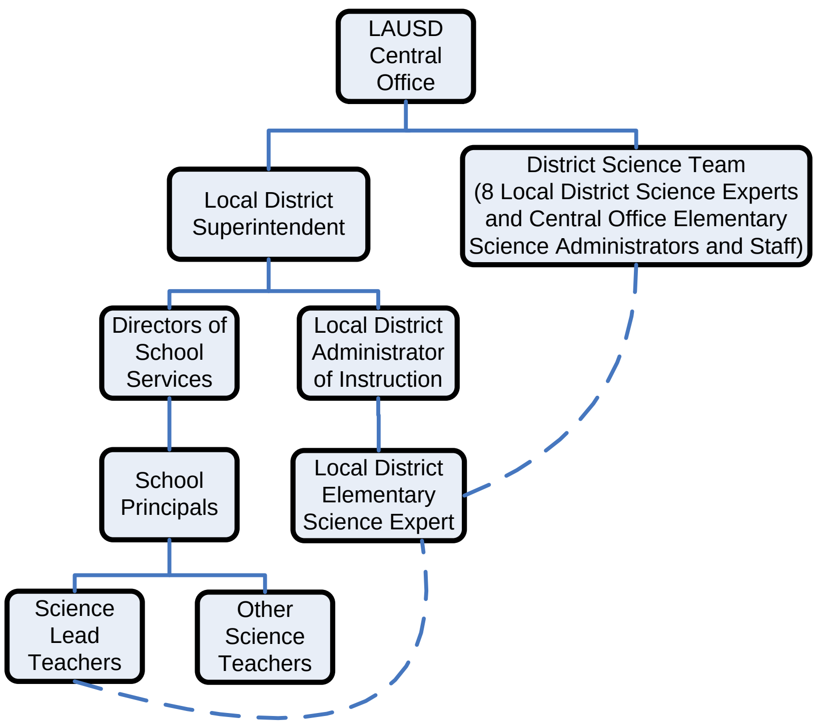

Figure 2. **LAUSD organizational structure and lines of authority.**

Consider the situation of local district science experts. Local district experts collaborated with central office elementary science administrators and staff to design and deliver district science PD. In consultation with principals, science experts determined when and where teachers might participate in the PD. As SLT coordinators, science experts provided SLTs with science PD and further guided SLTs' administration of periodic assessments and management of curriculum materials. Science experts also delivered PD to teachers who were not SLTs. However, when local district science experts met with central office elementary science administrators and staff as part of the District Science Team, neither had the authority to make decisions because each group reported to others who, in turn, rarely or never interacted.

Communication and leverage were also limited for principals and science experts because they, too, were situated in different lines of authority. A principal who identified problems with a science expert's work would have to go out of his or her way to get the director of school services to address the issue with the local district superintendent. The local district superintendent would then have to expend significant effort to push the issue back down through the local district administrator of instruction to the expert. Because local superintendents, administrators of instruction, and directors of school services pressured everyone under them to keep the focus on math and reading/ELA, the organization did little to identify and resolve barriers to efficient instructional support for science.

From the other angle, experts reported they often did not even try to address principals' lack of support for science. One expert reflected the view expressed by most when he said:

> Well, the best I can do to encourage [science planning time] is to encourage the science lead teachers to ask for that time from their leadership. I haven't had a whole lot of face-to-face time with the principals this year. I did in the past, but this year has just been one of those years where other district priorities took over. At principal meetings, that would be the time I could talk to principals about creating that time. Unfortunately, principals have their own leadership, which is the directors [of school services], here and at the local district offices. And if they don't value science, then they aren't going to be pushing it as a priority, and it becomes a lower priority at the school.

Fragmented lines of authority also characterized the relationship of experts to SLTs and thus constrained strategies for influencing SLT practice. This is illustrated in the following interchange with a local district expert.

> I: I am really curious about the role of the SLTs and if you think that their role has been effective, and if it hasn't been effective, why that would be?
>
> R: Those that have been effective, I think, are the ones that volunteer for it. Those that are ineffective are working with administrators saying . . . I need you to do it. Then, we get a little bit of push back, a little bit of resentment. "Well, my principal made me do this," and I always say, "Well, go to your contract and read it. You can say no." "Well, I can't say no." "Well, okay, then that is a personal decision." Me, if I really don't want to do something, I am not going to do it. I don't care how much money is there. But we do have a few teachers that literally collect the paycheck. It is the same with classroom teachers. There are fabulous teachers, and then there are other ones that you go—"You would really enjoy a career in retail." . . . I think a lot of it comes from the ones that are successful, even in the toughest of the schools I work with; it is me supporting them a lot and just being there for them. They shoot me an email, I

> give them a call, and they all have my cell number. I think it is that personalization. "If this is becoming too tough for you, let me call your administrator because you are not just a classroom teacher. You are a classroom teacher with this additional responsibility, but what they are asking you to do is really above. Let's clarify the role and make sure that they understand it, and maybe they do expect a little bit more, but let's have a conversation about it." I think it is just supporting them and backing them up, and if they need troubleshooting, doing that. My whole thing is that I am not going to just do it for you. Let's build some capacity in there too. If it takes me coming out to your school site and logging on for periodic assessment data, that you don't know how to do it because you only saw a PowerPoint on it, then okay I will do that.

Thus, for better or worse, district experts turned first to internal professional accountability to influence SLT performance. If official authority was needed, SLTs could rely only on a subset of principals willing and able to attend to matters.

Such fragmentation characterized much of the broader organization. We believe a major reason for this is that role definitions and reporting hierarchies were largely divided into instructional and operational lines. This structural characteristic of the district as a whole is reflected in the organization of authority into one line for school administrators and their supervisors and another for instructional support staff such as science experts and their supervisors.

Summary

The larger state, district, and MSP contexts shaped formal and informal LAUSD policies and organizational structure in several important areas. First, the context encouraged heavy emphasis on math and reading/ELA in response to state and federal accountability systems as well as beliefs about the foundational importance of these subjects. Second, district adoption of FOSS led to a channeling of most of the material, human, and social resources available for elementary science into the implementation of that system. This resulted in a correspondingly sharp drop in all resource types available for SCALE immersion PD. Third, organizational authority was highly fragmented, with key role groups separated into distinct lines of authority for instruction versus operations. To the extent that instructional support staff and principals cooperated to advance a shared vision and strategy for science teaching and learning, the effort resulted primarily from informal alliances constructed by parties in face-to-face interaction.

In Part II of this paper, we will expand on the perspectives of teachers, principals, and science instructional support staff about the effects of the district context and policies discussed here on actors' ability to carry out the district science reform as envisioned.

The Road Ahead for Elementary Science Improvement in LAUSD

The conditions under which LAUSD and its partners have endeavored to improve elementary science teaching and learning for the last 5 years have been challenging. Yet, the future may be even more daunting. The national economic recession has been devastating in California. With plummeting state revenues, budget shortfalls are being passed on to school districts and other local entities. At the time of this writing, LAUSD faces a staggering $718 million deficit for the coming year, and the district is considering laying off up to 8,500 employees, increasing class sizes, and cutting programs (Blume, 2009). All indications are that the science expert position will be eliminated and the number of science instructional support staff and administrators will fall from the current level of approximately 30 to only 3 in the coming year. Even if the state forwards a substantial portion of federal stimulus funds to districts such as LAUSD, major job cuts seem unavoidable. In view of the moderate emphasis given to science relative to math and reading/ELA in LAUSD, PD and other support for science may well largely disappear.

At the same time, Ray Cortines is back in the LAUSD superintendency and reasserting a decentralization strategy. A transfer of authority and responsibility from central to local districts is already under way and may well intensify. However, with staffing cuts, the resources needed by local districts to meet instructional responsibilities will not be part of the deal. This is not to say the decentralization strategy is necessarily wrong. Indeed, it may be unavoidable if, as expected, the central office capacity for instructional support is all but eliminated. That said, even if decentralization turns out to have been the best option available, the circumstances under which it is to occur will likely generate new problems faster than they can be addressed in the new administrative environment. Elementary science could well become an organizational outpost where teachers are left to fend for themselves.

Ironically, federal policy is now poised to increase the emphasis on science by including it with math and reading/ELA in AYP calculations under NCLB, beginning in 2010. Many LAUSD actors told us science would never get its due until there was accountability pressure for student achievement in science. That pressure appears to be in the offing. However, the prospects of LAUSD’s meeting rising federal expectations for science achievement just as the district capacity for science support is being decimated seem very bleak indeed.

References

Blume, H. (2009, April 1). School board OKs cuts, delays vote on others. *The Los Angeles Times*, p. 12.

Borman, G., Gamoran, A., & Bowden, J. (2009, April). *Growing capacity or dissipation? Second-year outcomes of a school-randomized trial of the effects of professional development on student achievement in elementary science.* Paper presented at the 2009 annual meeting of the American Educational Research Association, San Diego, CA.

Bruch, S., Grigg, J. A., & Hanselman, P., (2009, April). *Up to the classroom door: Effects of a school-randomized trial.* Paper presented at the 2009 annual meeting of the American Educational Research Association, San Diego, CA.

Fullan, M. (with Stiegelbauer, S.). (2001). *The new meaning of educational change* (3rd ed.). New York, NY: Teachers College Press.

Gamoran, A., Anderson, C. W., Quiroz, P. A., Secada, W. G., Williams, T., & Ashmann, S. (2003). *Transforming teaching in math and science: How schools and districts can support change*. New York, NY: Teachers College Press.

Glennan, T. K., Jr., & Resnick, L. B. (2004). School districts as learning organizations: A strategy for scaling education reform. In T. K. Glennan, Jr., S. J. Bodilly, J. R. Gallagher, & K. A. Kerr (Eds.), *Expanding the reach of educational reforms: Perspectives from leaders in the scale-up of educational interventions* (pp. 517–563). Santa Monica, CA: RAND. Retrieved from http://www.rand.org/pubs/monographs/2004/RAND_MG248.pdf

Halverson, R. (2004) Accessing, documenting and communicating the phronesis of school leadership practice. *American Journal of Education, 111*(1), 90–122.

Lal, S. R., & Osisioma, I. (2009, April). *The classroom perspective: Exploring the complexities and challenges of implementing a fourth-grade science immersion curriculum*. Paper presented at the 2009 annual meeting of the American Educational Research Association, San Diego, CA.

Lauffer, H. B., & Lauffer, D. (2009). Building professional development cadres. In S. Mundry & K. E. Stiles (Eds.), *Professional learning communities for science teaching: Lessons from research and practice* (pp. 55–72). Arlington, VA: NSTA Press.

Los Angeles Unified School District. (2009). *District information*. Retrieved from http://notebook.lausd.net/portal/page?_pageid=33,48254&_dad=ptl&_schema=PTL_EP

Loucks-Horsley, S., Love, N., Stiles, K. E., Mundry, S., & Hewson, P. W. (2003). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press.

Mumme, J., & Seago, N. (2002, April). *Issues and challenges in facilitating videocases for mathematics professional development.* Paper presented at the annual meeting of the American Education Research Association, New Orleans, LA.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

No Child Left Behind Act of 2001, Pub. L. No. 107-110, 115 Stat. 1425 (2002).

Olson, S., & Loucks-Horsley, S. (Eds.). (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: National Academy Press.

Porter, A. C., Garet, M., Desimone, L., & Birman, B. (2003). Providing effective professional development: Lessons from the Eisenhower program. *Science Educator, 12*(1), 23–40.

Resnick, L. B. (2004). *The SCALE teaching and monitoring systems: An analytic guide for district planning*. Madison: University of Wisconsin–Madison, Wisconsin Center for Education Research.

System-wide Change for All Learners and Educators. (2006). *Rot it right: The cycling of matter and the transfer of energy*. Retrieved from http://notebook.lausd.net/pls/ptl/docs/PAGE/CA_LAUSD/FLDR_ORGANIZATIONS/FLDR_INSTRUCTIONAL_SVCS/INSTRUCTIONALSUPPORTSERVICES/ISS_PRE_K_12_SCIENCE/ISS_ELEM_SCI_RESOURCES/ROT%20IT%20RIGHT%202006FINALREVISION_SM.PDF

System-wide Change for All Learners and Educators. (2008). *Weather: Forces and prediction.* Retrieved from http://www.lausd.k12.ca.us/District_2/resources/science/08-09/Weather%20Immersion%20Unit%20-%20Optimized.pdf