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System-Wide Reform in Science: Student-Centered Inquiry at Scale Part II

Eric J. Osthoff
Wisconsin Center for Education Research
University of Wisconsin–Madison
erico@education.wisc.edu

Vansa Shewakramani
Wisconsin Center for Education Research
University of Wisconsin–Madison
vshewakr@ssc.wisc.edu

Kimberle A. Kelly
Los Angeles Unified School District
akimkelly@gmail.com

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Wisconsin Center for Education Research
School of Education • University of Wisconsin–Madison • http://www.wcer.wisc.edu/

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System-Wide Reform in Science: Student-Centered Inquiry at Scale Part II

Eric J. Osthoff, Vansa Shewakramani, and **Kimberle A. Kelly**

Introduction

This paper traces the arc of an elementary inquiry science reform initiative undertaken in the Los Angeles Unified School District (LAUSD), the second largest district in the nation. The heart of the initiative was teacher professional development (PD) for the implementation of science "immersion" units. Such units—an especially ambitious instantiation of inquiry science teaching and learning, as advocated in the national science standards (National Research Council [NRC], 1996; Olson & Loucks-Horsley, 2000)—were designed to engage students in the full cycle of inquiry using conceptually interrelated investigations lasting 6 weeks or more. The intended reform strategy consisted of 1-week PD summer institutes in Grade 4 Life Science and Grade 5 Earth Science, with 2 follow-up days each during the school year, and further district support to help institute participants build grade-level capacity for immersion teaching and learning. The goal of the initiative was to foster immersion teaching and learning "at scale," as defined by Elmore (1996), when he underscored the need for academically rigorous standards-based reform to go beyond broad superficial adoption to changing practice at the "instructional core." This includes attending to conceptual understanding and problem solving as much as memorization and procedural knowledge. According to constructivist cognitive scientists (Bybee, 2002; 2003; Bybee et al., 2006, July; NRC, 1999), not to mention immersion PD and unit designers, it also required making instruction more student centered and inquiry oriented.

Research interest in how organizational capacity relates to the breadth and depth of reform has risen steadily through the successive waves of standards-based reform that have unfolded since being sparked by *A Nation At Risk* (National Commission on Excellence in Education [NCEE], 1983), over 25 years ago. Initial research on organizational capacity focused primarily on state education agencies (Firestone, Fuhrman & Kirst, 1991; Fuhrman, 1994), as state legislatures charged them with pushing districts and schools to intensify efforts to ensure the success of all students in traditional academic content. Often this took the form of state actions to increase the amount of students taking upper-level high school math and science courses (Clune & White, 1992).

Interest in teacher and school capacity for standards-based reform ascended as one professional organization after another issued curriculum standards and frameworks designed to foreground what some call a "thinking curriculum" (Resnick, 2010). Particularly important early efforts to emphasize student understanding of core disciplinary concepts in standards-based systemic reform included *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 1989), *Science for All Americans*

(American Association for the Advancement of Science [AAAS], 1990), and the *National Science Education Standards* (NRC, 1996).

It was in the context of a growing commitment to intellectually challenging content for all students that Smith and O'Day (1991) advanced an appropriately comprehensive framework for aligning major components of K–12 policy (e.g., standards, assessments, accountability, and teacher development) at all levels of the system (e.g., states, districts, schools, and classrooms). In so doing, Smith and O'Day acknowledged that standards-based reform for challenging content would require going beyond mere intensification of traditional instructional content and practice to developing and implementing new knowledge and skills.

Much of the research on school capacity from the last 2 decades focuses precisely on the role of school capacity in standards-based reform for student understanding. Examples include studies that showed how the teacher professional community—one important aspect of school capacity—is positively and strongly associated with student achievement on intellectually challenging content in schools undergoing organizational restructuring (Louis, Kruse, & Marks, 1996; Newmann & Associates, 1996).

More recently, Gamoran et al. (2003) demonstrated the analytic value of an *organizational resources* conceptual framework for identifying a full complement of important school capacity dimensions and a dynamic theory of how the dimensions interact to support or undermine teaching for conceptual understanding in math and science. As discussed in the Conceptual Framework section of this paper, Gamoran et al. (2003) show that optimizing teaching and learning for understanding for all students requires coordinated use of organizational resources to foster capabilities desired in school actors both individually and collectively. This entails using material resources (e.g., PD time) to enable individual actors to acquire appropriate knowledge, skills, and beliefs (i.e., human resources), plus the further use of material resources to enable groups of actors to work together to forge shared knowledge and practices (i.e., social resources) that support teaching for understanding.

In this paper, we utilize the Gamoran et al. (2003) organizational resources framework to guide our investigation into how the science-immersion reform played out for teachers and principals in 40 randomly-selected LAUSD schools that were encouraged to participate in immersion PD and then implement Grade 4 and 5 immersion units as part of the System-wide Change (SWC) study, a randomized cluster trial utilizing achievement, classroom observation, survey, and interview data.[1] We also analyze comparison data from an additional 40 randomly selected schools. The following is the substantive question guiding our investigation:

[1] See Borman, Gamoran, and Bowdon (2008) for information about the design and findings of the randomized cluster trial part of the study.

How are district and school material, human, and social resources allocated and coordinated so as to foster or impede the capacity of teachers to implement ambitious inquiry-oriented science instructional reforms such as immersion?

Two assumptions pervade our analysis. First, we recognize that organizational resources have a dual nature. They represent the means by which principals and teachers may build capacity for instruction that targets inquiry and conceptual understanding, while simultaneously the resources in place at the onset of a reform initiative constitute the very organizational context that shapes principal and teacher responses. Attributing such duality to organizational resources mixes structural and phenomenological perspectives in the interplay of context and reform, thus resembling the approach exemplified by Fullan (2001).

Our second assumption (evident in the parallel evolution of educational reform policy and organizational research) recognizes that reform initiatives vary widely by type, and the success of any given initiative depends on qualitative as well as quantitative aspects of district and school capacity. Glennan & Resnick (2004), for example, explain how simultaneous pursuit of intellectually challenging content *and* equitable achievement in contemporary standards-based reform places unprecedented capacity demands on district and school organizations.

These demands are evident in how 20th-century reforms in American schooling tacked heavily toward either equity or excellence. For example, during the Cold War, James Conant (1959) championed an intellectually challenging science and math curriculum for the top 10% of American high school students. In contrast, the first wave of instructional reform launched in response to *A Nation At Risk* (NCEE, 1983) sought to increase equity by mandating bread and butter courses such as Algebra I and Biology for high school graduation. As the clientele in college gateway courses grew larger and more diverse, the traditional emphasis on memorization-based and procedural knowledge (Porter, Kirst, Osthoff, Smithson, & Schneider, 1993) persisted. It would take a subsequent wave of policy advocacy, spearheaded by professional organizations with initiatives such as the NCTM Standards (NCTM, 1989), and the *National Science Education Standards* national science standards (NRC, 1996) to stimulate and focus widespread commitment to the principle that all students deserve and need a curriculum that balances an emphasis on basic skills with teaching for conceptual understanding and application of conceptual knowledge to real-world problems. Pursuing equity and excellence simultaneously places unprecedented demands on districts, schools, and teachers.

The immersion curriculum at the heart of the present study represented an especially ambitious attempt at balanced cognitive demand. The instructional vision for immersion units was operationalized through an design process that attended first and foremost to matters of conceptual flow, letting the central ideas of the units determine the scope and sequence of memorization-based and procedural knowledge needed to flesh out the conceptual schemas the units were intended to help students construct. Fostering teacher familiarity with, and appreciation for, the instructional design of immersion units then guided the design of the PD institutes.[2]

Though we did not anticipate it at the beginning of our study, events in LAUSD unfolded so as to allow, if not demand, adding a comparative dimension to our analysis of the relationship between organizational resources and reform implementation. This was prompted by district adoption and rollout of a second elementary science curriculum in the summer of 2007, just as the SWC study was poised to enter its second year of data collection. This occurred in response to the then most recent California K–8 science textbook adoption cycle, which took effect in the 2007–08 school year. Although the state provides much of the money for textbook purchases, only materials on the state list may be bought with state funds. The immersion units were *not* on the state adoption list, and, because immersion units only covered up to approximately one-third of the state standards per grade level, the district added the Full Option Science System (FOSS), which was considered by many to also be "inquiry-oriented." Indeed, one district science expert and the immersion unit developer both believed that the district's choice of the kit-based FOSS program over traditional textbook-based curricula occurred in part because of how the immersion initiative had deepened the commitment of the district's science professional community to inquiry science.

Nevertheless, FOSS and immersion differ in important ways. More scripted and teacher-centered, FOSS, for example, tends to posit questions for scientific investigation, whereas immersion encourages teachers to elicit students' prior knowledge and use it to scaffold students' formulation of their own scientific question to guide initial inquiry. Even if students need to collect evidence and use it to hone their question before proceeding, immersion developers believed there would be a payoff in greater student engagement and readiness for conceptual cognitive work. Consequently, immersion demands more extensive teacher decision-making in the flow of instruction.

Instructional design differences between the two curricula were associated with differing assumptions about how organizational resources at the district and school level needed to be retooled for successful enactment of the respective innovations. This, and the fact that, unlike immersion, the FOSS initiative would not enjoy support from the National Science Foundation's Mathematics and Science Partnership (MSP), resulted in markedly different PD models for the two curricula. Contrasting the FOSS and immersion initiatives helps vivify the ambitiousness of the immersion vision of instructional practice and the distinctively broad and deep array of organizational resources needed to foster student understanding through highly student-centered inquiry science.

[2] See Kelly, Chalaganyan, and Hernandez (February 2012) and Condon and Schrager (2008, March) for additional background on immersion PD institutes.

Analytic Focus and Organization

This paper first summarizes the science instructional attitudes and practices of principals and teachers in the 80 schools in the SWC study. This includes 40 control schools in which teachers were not permitted to participate in immersion PD during the study, and 40 “immersion schools” in which teachers were encouraged as part of the SWC study to attend immersion PD institutes and implement immersion units in Grades 4 and 5. Second, the paper uses vignettes of implementation based on the experience of principals and teachers in two immersion schools in order to illustrate dominant themes in the larger interview data set of interviews with 90 teachers and principals from immersion and comparison schools, and 22 science staff and administrators from LAUSD local districts and central office.

In this paper, we provide an overview of the immersion intervention; discuss the Gamoran et al. (2003) organizational resources framework and its implications for the present study; outline sample design and methods; and summarize patterns in resource allocation, use, and reform implementation as experienced in the larger sample. The school-level focus in this paper complements and builds on Part I of this study (Osthoff, Shewakramani, & Kelly, February 2010), which concentrated on aspects that both constrained and enabled *district* support for elementary immersion implementation. In this paper, we note those main findings about the district context before turning to the school vignettes.

Overview of the Intervention

Labor-intensive PD was at the center of the LAUSD science immersion initiative. The PD design consisted of a resource-intensive 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 simultaneously in all 400 LAUSD elementary schools. Consequently, district leaders nominated 190 schools, 80 of which were then randomly selected for participation (10 schools in each of the eight LAUSD “local districts”). Of these 80 schools, 40 were randomly assigned to the treatment group (immersion schools), and 40 served as comparison schools. Each subsample was again stratified by local district.

A phased rollout of the Grade 4 and Grade 5 PD institutes was necessitated by constraints in resources and organizational capacity. PD activities were targeted at immersion schools in Grade 4, beginning in 2006–07, and in Grade 5, beginning in 2007–08. Each immersion school was strongly encouraged to send their grade-level science lead teacher (SLT) and a grade-level colleague of the school’s choosing to the Grade 4 and Grade 5 institutes.

Immersion Units

The curricula for the intervention were called immersion units because they immerse teachers and students in the full cycle of science inquiry in daily lessons over a 6–8 week period. Grade 4 immersion institutes featured *Rot It Right* (System-wide Change for All Learners and Educators [SCALE], 2006), a Life Science unit (described in the next section) in which students investigate decomposition to better understand the flow of energy through food webs. Grade 5 institutes featured *Weather: Forces and Prediction* (SCALE, 2008), which engaged students in investigating weather patterns in the United States generally and southern California specifically.

Immersion units were standards-based in three ways: First, the curricular content was aligned to state and district standards for science at the targeted grades. Second, like the *National Science Education Standards* (NRC, 1996; Olson & Loucks-Horsley, 2000), the immersion instructional approach emphasized posing scientific questions, giving priority to evidence, connecting evidence-based explanations to scientific knowledge, and communicating and justifying explanations. More than most curricula, immersion relied on inquiry methods to address core content and organizing principles of scientific understanding. Third, heeding the NRC'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 important science concepts while progressing through the full inquiry cycle.

Professional Development Institutes

PD institutes constituted the other major element of the intervention. 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) help teachers deepen their content knowledge; (b) model strategies for teachers to use with their students; (c) support teachers to serve in leadership roles; and (d) feature active group learning for teachers.

The resulting Science Immersion Model for Professional Learning (SIMPL) (Lauffer & Lauffer, 2009), 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 within in the larger unit. In a typical session, teachers received a brief introduction to the lesson, followed by a longer segment in which they then engaged in the lesson in the role of learner (i.e., student). This allowed teachers to personally experience the cognitive activities in which they would ultimately seek to engage students. Participants were expected to hold comments and questions reflecting their concerns until the end of the session, when the lesson would be deconstructed from that perspective.

To foster sustainability and capacity building, the institutes were originally designed to be used with a "train-the-trainer" model in which SLTs would attend PD and, with limited but significant support from their local district science expert, share the immersion unit and approach with colleagues in their respective schools. This is an example of human resources (e.g., attitudes and commitments to science teaching) being leveraged to create social resources (e.g., a collective focus on student learning), thus helping to transform groups into professional communities. However, the institutes, as implemented, did not sufficiently train SLTs to disseminate the immersion approach. The expectation that SLTs would formally train other teachers was eventually dropped from the district's position description for SLTs. Despite insufficient systemic support for widespread sharing of immersion units by institute participants, sharing did occur in some schools, thereby providing some insight into the dynamics of informal peer collaboration around immersion.

Conceptual Framework

As noted, our study draws on the dynamic model of organizational support developed by Gamoran et al. (2003). This model addresses how districts, schools, and teachers respond to challenges while implementing 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 described, Gamoran et al. (2003) distinguished three kinds of organizational 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. (2003) identified three main organizational challenges to teaching for understanding: (a) providing adequate teacher resources, (b) aligning commitments and goals, and (c) sustaining the realized change. Given that resources both enable and constrain reform efforts (discussed below), our focus on actors' access to and transformation of resources allows us to address each of these challenges in our discussion of implementation of system-wide elementary science reform in LAUSD.

Material, Human, and Social Resources

Material resources are the "things" teachers need in order to teach (e.g., money, 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 them into social resources.

Social resources are the attributes of roles, relationships, and communication (e.g., norms, information flow, and 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 prime 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 extent and process by which individual resources become communal.

Groups, Professional Communities, and Resource Creation and Allocation

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. When 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 change. 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, partly because resources can constrain as well as enable. 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. For example, the priority given to a subject such as science may be elevated by adding it to the list of subjects included in standardized testing, or accountability, or both. However, if the tests emphasize recall of disembodied science factoids, teachers may respond by curtailing inquiry-oriented science instruction that targets conceptual understanding, analysis, and application.

Autonomy is another resource that constrains and enables. In LAUSD, elementary teachers have considerable autonomy in deciding how much science to teach and when. Because principals do not know precisely when science will be taught, they are less likely to observe it and thereby learn how to better support instruction. In this way, teacher autonomy may preclude a type of interaction by which groups become communities of practice.

Transforming groups into professional communities is of special interest because such communities are believed to be especially effective vehicles for reshaping grounded practice to reflect reform vision and goals. 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 work in environments already densely populated by policies and resources. Where reform is undertaken, at least some actors endeavor to purposefully change certain practices. We posit that reformers’ theories of change, however tacit, typically involve reallocating existing organizational resources or creating and directing the dissemination of new organizational resources (or both) in order 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 ineffectively 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 math and reading/English Language Arts (ELA), not science. Allocating some of the available school planning time to science PD and instructional planning represented a potentially effective strategy for enhancing teachers' opportunities to share human resources (e.g., knowledge of and commitment to student-centered inquiry teaching and learning) needed to enact instructional practices envisioned in immersion. However, access to such planning time was much impeded by an overriding commitment at the district, state, and national level to the primacy of math and reading/ELA 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 skills) 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 that reformers and leaders need to construct and orchestrate in order to foster school-wide teaching for conceptual understanding. Before continuing with this analysis, we describe the SWC study, and summarize findings about district context from the previously published Part I of this paper.

Study Design and Methods

Sample

The focus of this paper is on the experiences of those actors who are implementing immersion units in LAUSD over the course of the SWC study. 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, when engaged in various organizational tasks, experience differential access to relevant information and resources. Recognizing this fact, we developed a series of interview protocols to explore actors' perceptions of the intended and actual elementary immersion science reform. Over the course of 3 years, we obtained interviews from the following groups:

- central office administrators and local district administrators charged with general instructional oversight and those specifically responsible for science;
- science experts from each local district appointed to facilitate instruction and PD in elementary science;
- principals of sampled immersion and comparison schools; and,

- teachers of sampled immersion and comparison schools, in particular grade-level SLTs.

Sampling strategies each year reflected evolving analytic priorities. In 2006–07, we targeted Grade 4 teachers in the 40 immersion and 40 comparison schools who were selected for observation in order to obtain data that expanded on what we saw in district classrooms. The SLT and a randomly-selected grade-level colleague were targeted for observations and interviews at each school.

In 2007–08 our focus shifted to understanding why school actors did or did not participate in the immersion reform. To limit data collection burden, we targeted only 16 immersion schools. In each local district, we sampled one school in which the Grade 4 SLT attended the immersion PD summer institute as intended, and another school in which the Grade 4 SLT did not attend, plus their respective principals. When possible, we optimized the interview participation by choosing schools whose SLTs had previously participated in classroom observations.

In 2008–09, we again targeted 16 schools. In each local district, we selected one immersion and one comparison school, targeting the current (or former if there was no current) Grade 4 SLT, Grade 5 SLT, and principal. Selection criteria included participation in observations and interviews across all years of the study, as well as the length of time actors had served in their role as SLT or principal. We calculated a score for each school based on these characteristics and selected schools in each local district with the highest scores. This was done to maximize the amount of corroborating data available in conjunction with the interview in the final year of data collection.

In Years 2 and 3, we also targeted actors at the central and local district levels responsible for supporting schools in implementing reform strategies in their context in order to understand the emphasis placed on the science immersion reform at the administrative level.

Of 129 interviews conducted for the study, 117 were at the school level. In immersion schools, 75 interviews were conducted with actors from 31 different schools. In comparison schools, 42 interviews were obtained from 22 different schools. Table 1 shows how interviews were distributed by role group.

Table 1. **Interview sample, by group and year: 2007–2009.**

Group	Year 1 Interviews (Spring 2007)	Year 2 Interviews (Spring 2008)	Year 3 Interviews (Spring 2009)	Total
Central administrators	Not sampled	4	Not sampled	4
Local district administrators	Not sampled	4	1	5
Science experts	Not sampled	7	6	13
School principals	Not sampled	13	14	27
Teachers	49	12	29	90
TOTAL	**49**	**40**	**40**	**129**

Protocol Design and Development

The selection of these interview topics reflected in part our decision to use Gamoran et al.'s (2003) conceptual framework to guide inquiry and analysis. We designed the semi-structured interviews to elicit respondents' experiences with and perceptions about:

1. goals and vision for elementary science teaching and learning as well as the immersion reform;
2. the nature, distribution, and use of available district organizational resources to support science teaching and learning, including immersion implementation;
3. supports and impediments affecting science teaching and learning in schools, including district, state, and school policies and contextual factors;
4. the alignment of the immersion reform with other state and district instructional policies and priorities;
5. the breadth and quality of science PD, especially PD related to the immersion reform and FOSS;
6. the effects of PD participation on the breadth and quality of classroom implementation of immersion units and FOSS kits; and,
7. the success and sustainability of science immersion teaching and learning.

Data Collection and Management

Interview data were collected each spring to allow sufficient time for participants to experience and reflect on the entire school year. Interviews in Years 2 and 3 were cumulative in the sense that they asked about experiences since the initiation of the immersion reform. Three University of Wisconsin–Madison researchers conducted LAUSD central and local district office interviews, while LAUSD research and evaluation staff conducted the principal and teacher interviews. LAUSD staff underwent training each year, which consisted of protocol review and practice with other staff members before doing live interviews with teachers. While the quality of the interview data is very good for central and local district staff, it is uneven for the principals and teachers. In part, this reflects the fact that a much larger group of interviewers were responsible for teacher and principal interviews, increasing the variability of interviewers' skill in eliciting detailed data. However, the quality of interviews fluctuated even for relatively proficient interviewers. Frequently this was due to the respondent's cooperation level, or to some respondents having less time than needed for interviewers to follow-up on answers. Also, several interviewees exercised their prerogative to not have their interview audio recorded, thereby limiting data capture to interviewer notes.

All the digital audio files of interviews were transcribed and coded. We used NVivo to develop a coding scheme based on the organizational resource model of Gamoran et al. (2003). Table 2 contains a list of material, human, and social resources in the coding scheme.

Intensive coding was done by two University of Wisconsin–Madison researchers and two LAUSD research staff members working closely together to ensure consistency. This process involved extensive coder calibration based on the node definitions in the codebook in Appendix 1. Calibration began with independent coding of sample interviews within each role group, followed by debriefings in which coding differences were discussed and resolved. Coders also conferred periodically with the larger project team to ensure that findings could be effectively triangulated across interview, survey, and classroom observation data. The analysis presented here reflects the coding scheme used and focuses on the intersection of resource codes with the intended and actual intervention, by interviewee, role group, and school.

***Table 2*. Types of material, human, and social organizational resources.**

Material	Human	Social
• Money • Teaching tools/supplies • Time • Professional development time • Technology • Professional knowledge base • Distribution of inquiry science material resources	• Professional knowledge • Leadership • Disposition to learn • Uncertainty • Commitment to teaching practice • Attitudes toward inquiry science teaching • Distribution of inquiry, immersion, and FOSS human resources	• Professional community o Shared sense of purpose o Collaboration o Collective focus on student learning o Deprivatized practice o Reflective dialogue o Membership • Reward systems • Professional standards • Autonomy • Connections to larger professional community • Connections to parents and larger community • Shared technical language • Shared history and social cohesion • Roles and relationships within the community • Dynamics of communication

Part I Findings on the District, State, and National Context of Reform

The focus for findings in this paper is on how principals and Grade 4 and 5 teachers experienced the effects of the immersion and FOSS initiatives on organizational resources in support of inquiry science. Part I of this paper (Osthoff, Shewakramani, & Kelly, 2010), which is based on interviews with district-level actors, presents complementary findings on the district context for reform. The following synopsis of key findings from the earlier paper sets the stage for the school-level focus of the present paper.

For at least the last 20 years, LAUSD has vacillated between centralizing and decentralizing impulses, typically in conjunction with changes in superintendents and other district leadership. Immersion and the SCALE Math Science Partnership, of which it was a part, came to LAUSD less than 2 years into Roy Romer's unusually long tenure of greater than 5 years. Under Romer, the momentum shifted toward centralization and a significant increase in the size of the central office science staff and its capacity to advocate for curricular reform. However, the ongoing struggle between centralizing and decentralizing forces had led to highly fragmented organizational authority, including separate lines of authority over instruction and operations. The structural division of authority impeded coherent support for instructional change initiatives. A further barrier to reform progress was high turnover among district administrators as well as teachers; actors were rarely in the system long enough to form communities with robust social resources of the type needed to change practices at the instructional core. The stature and resources of the SCALE MSP were powerful enough to launch the immersion effort, but not necessarily to ensure sustainability.

State and federal accountability policies established both a floor and ceiling on support for inquiry science reform. Mandated testing for science as well as math and reading/ELA meant science performance could not be ignored. However, district and school administrators at all levels allocated instructional resources disproportionately to favor math and reading/ELA because all the powerful sanctions under No Child Left Behind (2002) were tied to those subjects. Teachers and administrators alike felt this explained district guidelines directing teachers to provide only 100 minutes in science, while math and reading/ELA received many times that amount.

As discussed earlier, the timing of the state textbook adoption cycle prompted LAUSD's adoption of FOSS with 1 year remaining in the present study. FOSS subsequently competed heavily with immersion for science instructional resources at all levels of the system, including the lion's share of funds for PD and curricular materials.

Finally, California and LAUSD were hit especially hard by the global recession, which took hold just as MSP resources for immersion PD were winding down. Although the district had built considerable capacity for immersion PD and science leadership at the level of local district science experts, funds no longer existed to put experts to work delivering immersion PD.

Study Findings

With this context in mind, we turn to a summary of patterns of organizational resources across the study, based on our guiding question:

> *How are district and school material, human, and social resources allocated and coordinated so as to foster or impede the capacity of teachers to implement ambitious inquiry-oriented science instructional reforms such as immersion?*

We discuss important patterns in material, human, and social resources from the perspective of interviewed teachers and administrators, beginning with patterns in the broader interview sample, followed by a closer look at two schools encouraged to participate fully in immersion PD and implementation.

Organizational Resources for Inquiry Science: Sample-wide Patterns

Material resources. The material resources cited by interviewees as having the greatest effect on science instructional quality were money, PD time, instructional time, teaching tools/curricula, and distribution of inquiry science classroom materials. In most cases, teachers perceived these material resources to be too scarce to support implementation of ambitious science instruction such as immersion.

The most important resource constraints were on money and time. Teachers cited a lack of teacher aides, limits on the use of substitutes (thus limits on release time for PD), diminishing funds for science equipment, and large class sizes as impeding their ability to conduct hands-on science lessons. They further cited insufficient instructional time for science, due both to the priority of math and reading/ELA and the extra classroom setup time associated with hands-on activities.

Other material resources of import to teachers were the immersion and FOSS curricula and classroom materials. Although most liked immersion and FOSS curricular design, teachers were concerned they might not know enough to use the material effectively. They valued PD time to learn how to use the materials and appreciated how extensively immersion PD modeled classroom use.

The availability of hands-on materials was problematic for both immersion and FOSS. Teachers were responsible for gathering their own immersion materials and felt that those units provided less instructional guidance to teachers, while simultaneously requiring more complex teacher decision-making in the flow of instruction. Although FOSS materials were provided to schools in pre-assembled kits, schools generally received fewer sets of each kit than there were teachers at a grade level. Consequently, problems arose in sharing kits across classrooms, especially in year-round schools. Teachers perceived the FOSS teachers' guide as a strength because it was more scripted and comprehensive than the one for immersion.

Human resources. The human resources most emphasized by interviewees were professional knowledge, a disposition to learn, commitments and attitudes toward inquiry science teaching, and opportunities for leadership roles in science instruction.

Without exception, teachers expressed positive attitudes and a strong commitment to inquiry science and the importance of hands-on activities, which are featured both in immersion and FOSS. Although teachers varied considerably in the depth of their conceptions of inquiry science, interviews suggested most had a serviceable foundation, while some appeared to have a firmer grasp, which might be expected to lead to more proficient implementation.

One pedagogical matter on which many teachers desired more PD was student questioning strategies to support scientific thinking. In regard to science content knowledge, many teachers felt they might not have enough to do justice to immersion and FOSS units. Between perceived scarcity of resources for PD time, sub release funds, sub availability, and pressure to optimize student learning by minimizing time away from school for things like PD, teachers often felt unsupported in addressing their professional learning needs.

Although science leadership roles existed, teachers and administrators expressed disappointment that the SLT role, as enacted, was primarily administrative. SLTs, who received a stipend of about $800 per year, spent most of their time coordinating FOSS and immersion materials and managing periodic assessment administration and scoring. Engaging in instructional conversations and activities with colleagues was rare. The absence of SLT funding at a level that allowed for genuine instructional leadership discouraged teachers from taking on the role. In the few instances where schools used aides to manage FOSS kits, SLTs were more likely to actively help other teachers with inquiry science implementation.

Whereas immersion PD was too resource intensive to be provided to all teachers at once, the district was able to mandate FOSS PD for all elementary teachers by limiting it to up to 3 days of PD per teacher. With such limited PD, teachers were more likely to attempt FOSS than immersion implementation. However, many FOSS implementers still had reservations about lesson quality.

In sum, district teachers and administrators generally understood and supported the idea of inquiry science. At the same time they recognized that limited material resources and the primacy of other content areas meant human resources were not adequately developed or utilized in support of the reform vision of science teaching and learning.

Social resources. When asked about social resources, interviewees focused most on autonomy, collaboration, professional community, deprivatized practice, shared sense of purpose, collective focus on student learning, administrative support and control, and connections to a professional community beyond the school. In general, teachers and administrators reported very little development of social resources around science instruction in LAUSD elementary schools.

Although very few teachers felt that they were part of a sustainable professional community when it came to science, they did feel that the mandatory training and collaboration time set aside for math and reading/ELA fostered a professional community around those subjects. While the majority of actors shared an overarching sense of purpose in terms of being intentional and rigorous educators, they expressed that this shared sense of purpose was more aspirational than actual when it came to science. In the vast majority of schools, teachers reported that little if any teacher interaction focused on science, and opportunities to observe one another teaching science were rare. Teachers expressed a need and desire for greater collaboration around classroom implementation of inquiry science—especially best practices for teaching science to elementary students and English language learners. Teachers also spoke very positively about the MSP SCALE partnership and highly valued the PD it provided, but time and budget constraints prevented them from participating as much as desired.

Teachers were generally satisfied with the level of administrative support they received from their local district science expert, but some reported that their principal's low science priority made it difficult to find time to communicate with their expert. What little time was devoted to developing social resources for science in the final year of the study generally went to collaboration around FOSS implementation.

Summary

Sample-wide interviews revealed considerable progress toward a vision for and desire to enact high-quality science instruction, but insufficient resources were allocated in support of the cause. Constraints on instructional time and PD funding, due to the higher priority given to math and reading/ELA, were persistent barriers. However, science still fared better than social studies and the arts. Resources devoted to science were sufficient for those teachers who were especially assertive in seeking them out, or happened to have an unusually supportive principal. This level of resources resulted in teachers being willing to try inquiry science in their classrooms, but often without the degree of preparation needed for sustained, highly proficient practice.

School Vignettes of Inquiry Science Reform

An important aspect of LAUSD immersion implementation that is obscured by analysis of the whole sample is the considerable differences between school immersion PD participation and the quality of related efforts to enhance professional community and instructional practice. Examining how the reform played out in schools provides insight into complex relationships that cannot be fully understood when examining sample-wide patterns. Interviewee comments show how the capacity of the district and partnership to design, initiate, and support curricular reform interacted with a school's initial capacity to engage productively in reform at the level of district support that was available. School capacity continued to be pivotal as it further developed, or failed to evolve, toward the reform vision of teaching and learning.

Below we examine the dynamics of reform in two schools that illustrate a range of responses to the immersion and FOSS initiatives. The first school, Baxter Elementary,[3] had two teachers who engaged in the immersion initiative in isolation from others. The second school, Hernandez Elementary, provides a good example of a Grade 5 team in which teachers integrated parts of the immersion *Weather* unit into instruction based primarily on a similar FOSS Earth Science kit (*Water Planet*). It would have been preferable to have conducted in-depth case studies on the chosen schools, including at least annual interviews with all Grade 4 and 5 teachers. However, the sample was too big to do this in all schools and there was no reliable way to predict which schools would eventually prove to be the most illustrative of important findings.

[3] Both school names are pseudonyms.

Therefore, we refer to the following sketches of school immersion implementation as *vignettes* rather than case studies. Our use of the term vignette is a reminder that our interview sampling frame allows only illustrative, not definitive, analysis of school-level reform dynamics. Table 3 shows the distribution of 9 interviews from the vignette schools over 3 years.

***Table 3*. School-level interview sampling frame for two vignette schools and sample, by year.**

School	Year 1 Interviews (Spring 2007)	Year 2 Interviews (Spring 2008)	Year 3 Interviews (Spring 2009)
Baxter Elementary		• Grade 4 SLT • Assistant Principal	• Grade 4 SLT (same individual as 2008) • Grade 5 SLT • Principal
Hernandez Elementary	• Grade 4 SLT		• Grade 4 SLT • Grade 5 SLT • Principal
Interview Sample	• Grade 4 SLTs (17 treatment & 14 control) • Other Grade 4 teachers (14 treatment & 14 control)	• 13 Principals • 12 Grade 4 SLTs (Treatment schools only)	• Grade 4 SLTs (7 treatment & 7 control) • Grade 5 SLTs (8 treatment & 7 control) • Principals (8 treatment & 6 control)

Each vignette begins with brief comments about the reform dynamics it illustrates and a note on school demographics. Next we discuss baseline school capacity for inquiry science at the onset of the immersion initiative, and how school actors subsequently coordinated relevant organizational resources. This includes allocating material resources such as PD time to build human resources for immersion instruction, and using additional material and human resources to foster collaboration and other social resources in support of immersion implementation. Our interest includes barriers to as well as supports for immersion implementation. We also provide a similar if abbreviated overview of the FOSS initiative to illustrate differences in how a given school responded to qualitative differences between the FOSS and immersion initiatives.

Baxter Elementary

Baxter is an example of a school that was assigned to the immersion intent-to-treat group but largely passed on the intervention before later engaging fully in FOSS. Comparing school responses to the two reform initiatives shows that the school was willing and able to grow its capacity for inquiry science instruction despite having declined to invest much in the immersion initiative.

As seen in Table 4, with slightly more than 1,200 students in, 2005–06, Baxter is somewhat larger than the other vignette school, which is significantly above sample average for immersion and comparison schools alike. Consequently, with six teachers each at Grades 4 and 5, Baxter had larger grade-level teams than the other vignette school. Baxter also had more non-white students (99%), and the highest percentage receiving free or reduced-cost lunch (44%). With 41% English Language Learner (ELL) students, Baxter, was somewhat above the immersion school mean (36%) for percentage of ELL students, and somewhat below the comparison school mean of 44%.

***Table 4*. School demographics in vignette, immersion, and comparison schools.**

School(s)	# Students (2005-06)	% Students Non-White (2006-07)	% Students Free Lunch (2006-07)	% ELL (2006-07)	Met AYP (2005-06)	# Grade 4 Teachers (2005-06)	# Grade 5 Teachers (2005-06)
Baxter	1206	.99	.94	.41	No	6	6
Hernandez	987	.97	.87	.43	Yes	5	5
Immersion Schools (*n*=40)	$\bar{x}$ = 780 S.D. 420	.86	.77	.36	.60	$\bar{x}$ = 4.1	$\bar{x}$ = 4.2
Comparison Schools (*n*=40)	$\bar{x}$ = 738 S.D. 398	.87	.78	.44	.65	$\bar{x}$ = 3.7	$\bar{x}$ = 3.8
All Schools (*n*=80)	$\bar{x}$ = 759 S.D. 407	.86	.77	.40	.63	$\bar{x}$ = 3.9	$\bar{x}$ = 4

AYP=Adequate Yearly Progress, a requirement of the No Child Left Behind Act

Immersion PD Participation and Unit Implementation

Both B-SLT4[4] and a grade-level colleague attended the 5-day immersion PD in summer 2006. B-SLT4 implemented the bulk of the unit in SY2006–07. In SY2007–08, B-SLT4 relied primarily on the FOSS Life Science materials, which she supplemented with 1 week of instruction based on a Rot It Right (RIR) immersion unit activity in which students grow radish seeds in the dark and sunlight to explore heliotropic plant behavior. In SY2008–09, B-SLT4 omitted RIR entirely. B-SLT4 noted that it had been her local district expert who had originally told her about immersion PD and encouraged her to attend. At the time the school had a different principal than the one we interviewed. BSLT-4 did not think that the principal had been aware that she had attended the summer 2006 PD institute.

B-SLT5 did not attend immersion PD of any kind, or implement any part of the immersion *Weather* unit. She said that she had never been given the option of attending

[4] Interviews were conducted in person, but blinded for database coding to ensure interviewee confidentiality. Neither the gender nor ethnicity of the interviewee is evident in many interviews. For clarity we refer to interviewees using a shorthand of their group label (e.g., SLT for science lead teacher) preceded by the first letter in their school’s name. For readability we refer to all individuals as female, which most in fact were.

immersion PD. District PD attendance records indicate that one other Baxter Grade 4 teacher went to a 5-day immersion PD. However, there was no indication in either SLT interview that any Baxter teacher besides B-SLT4 had participated in immersion PD or implemented any part of an immersion unit. Baxter's Assistant Principal (B-AP) was emphatic that no Baxter teacher had attended immersion PD or used curricula other than the district adopted FOSS program. The principal (B-Prin) said she did not know anything about science immersion units or whether any teacher in the school used them, but she didn't think any Baxter teachers had attended immersion PD.

Baseline School Capacity

Baseline material resources. Prior to immersion, a district-adopted textbook series from Harcourt was the main curricular resource for science. PD opportunities were available in the broader environment through the district's NSF-funded Urban Systemic Program in math and science, as well as through area colleges and universities. Participation in such PD opportunities relied entirely on teacher volunteerism and were more episodic than sustained.

Little in the interview data suggests that the school itself allocated material resources to science PD prior to immersion and FOSS. The allocation of instructional time to science was not an administrative priority. No pressure was put on teachers to cover science, especially in kindergarten through Grade 3, and teacher meeting time was rarely used to discuss science.

The most significant form of material support for science in place at the beginning of the SWC study was the addition of Grade 4 and 5 SLT positions in SY2004–05. Modest funding for the SLT as a supplemental teacher duty was important because it fixed responsibility for coordinating science instruction in the school with local district resources and expectations.

Baseline human and social resources. Before immersion and FOSS, Baxter showed great variability in human resources among teachers and very limited social resources to temper disparities in science instructional capacity and practice across classrooms. B-SLT4 told us: "Previously [science] was, if you wanted to do it, it was okay. If you didn't have time, you would not push." This suggests that teacher autonomy reigned, thereby leading to great variability in teachers' science instruction, including whether and how much science was taught, to say nothing of instructional content and methods.

B-Prin echoed B-SLT4's perception of teacher variability in science instruction while further indicating that each teacher's science knowledge and interest were the main factors accounting for their autonomous decisions about science instruction. At different points in the interview B-Prin commented along these lines about a former teacher: "In the past when they had a teacher with strong science background he taught a lot of science"; and, "I had a teacher that was really, really into science and he retired. So [in his class] there was probably more science than even what was on the daily curriculum."

As in the vast majority of study schools, the human resource *leadership* for science instruction was uneven and generally weak prior to immersion and FOSS. At Baxter, all interviewees except B-AP said science received less instructional time and organizational attention than mathematics and ELA, despite the fact that science emphasis had risen significantly in recent years. B-AP was the only Baxter interviewee, and perhaps the only one in the entire sample, who said she considered science to be treated as equally important to math and ELA by the district and school.

A second reflection of limited leadership for science was evident in how the SLT role tilted heavily toward administrative and procedural matters rather than collaboration on knowledge and practices. Before immersion and FOSS, the main responsibility of SLTs seemed to be to distribute and collect district and state science assessments. The role further included discussing assessment results with their grade-level team to identify possible areas for improvement. Such discussions may have provided SLTs with opportunities to facilitate discussion about specific learning challenges and appropriate instructional strategies, but our data are unclear about that.

Our data are clear that the focus on student science achievement began in SY2004–05, the year in which the district initiated science periodic assessments at Grades 4 and 5, and the state expanded testing to include Grade 5 science. All interviewees point to the advent of science assessments as a primary reason for increased attention to science in recent years. This factor cannot be disentangled from the impact of immersion or FOSS during the years of the SWC study.

Surveys administered in 2006 and 2008 and analyzed by SWC researchers (Hanselman, Grigg, & Bruch, April 2010) showed that Baxter teachers scored especially high on scale measures of *PD climate* and *principal leadership* in 2006, but declined somewhat by 2008.[5]

School Capacity-Building: Immersion

Immersion material resources. B-SLT4's participation in immersion PD required no school material resources because the institute was held during the summer and thus did not require substitute teacher coverage. B-SLT4 felt that immersion unit supplies were not an impediment to implementation because the unit required only readily available supplies such as empty plastic soda bottles, dirt, water, and vegetable organic matter. The school did not invest further in immersion by allocating teacher planning time to foster the spread of B-SLT4's knowledge about immersion teaching to other Grade 4 teachers.

Immersion human resource development. As noted, B-SLT4 was one of only two Baxter teachers who attended immersion PD, and possibly the only one who attempted to implement the unit. She reported teaching the bulk of the unit in SY 2006–07, a small part of the unit in 2007–08, and none thereafter. The interview excerpt below alludes to important ways that

[5] See Hanselman et al. (April 2010) for a description of the school capacity scales and discussion of how school capacity related to school responses to immersion.

immersion PD and implementation affected her science knowledge, instructional philosophy, and classroom practice.

> I: What would you say was the most important thing that you learned from that training?
>
> R: Developing the inquiry questioning of science.
>
> I: Has it had an influence on your classroom teaching?
>
> R: Yes because now … I don't just teach science [facts]. I actually have to make my students teach themselves the process of why are we doing this? How are we doing this? What is my final product of the experiment? What is all the data going to tell me? Now, it's not just me, me, me, telling the students all the information. It's actually making the students think about the information.

We see three important points related to human resource development in this excerpt. One, B-SLT4 got one of the main immersion PD takeaways hoped for by unit developers. Specifically, she deepened her appreciation of how questioning can be used to scaffold student inquiry in ways that lead to understanding, not merely acquiring facts and following experimental procedures. Two, B-SLT4 sees what she learned in immersion PD as continuing to guide her instruction even though she quit using immersion curricula in favor of FOSS. It would be interesting to consider the possibility of general differences in FOSS instruction between teachers who participated in immersion PD and those who did not. Unfortunately, the adoption and implementation of FOSS in LAUSD came too late in the study to include investigation of possible immersion spillover effects.

In school reform, increasing teacher human resources is but a means to promoting student knowledge and skills. The interview excerpt above and the one below suggest that B-SLT4 implemented some of the things she learned in immersion PD in classroom instruction.

> I: Overall, how did your students respond to *Rot it Right*?
>
> R: They seem to like the experiments. They liked the fact that they can understand how sunlight affects flowers and then how flowers affect the other organisms.
>
> I: Okay. Are there any particular challenges or benefits of teaching *Rot it Right* immersion unit with English language learners. First let's look at the challenges. Are there any?
>
> R: The challenges might be vocabulary at first, but then it is the vocabulary that benefits them because they understand it for the assessment. In the beginning, it's interesting. Also food chains and food webs give them a little bit of a challenge—the process of energy transfer.
>
> I: Anything about benefits?

> R: They see that once they understand the energy transfer and how the arrows (showing the direction of energy flow between organisms) are placed, they understand the things of how the sun, the plants and all the energy play a role in different food chains and food webs.
>
> I: In what way, if any, does student learning experience in *Rot it Right* differ from … a textbook?
>
> R: It is hands on. They see the flowers with sunlight and without sunlight. They chart the growth of the plant. They develop questions of how and why.

Based on such remarks, we consider B-SLT4 an example of a teacher who acquired significant human resources from immersion PD, followed by a meaningful attempt to share the scientific knowledge and habits of mind embodied in RIR with her students. In the end, B-SLT4 said she curtailed and then discontinued RIR use because she could not actually fit RIR instruction into the 3–4 hours a week she devoted to science, and because of steadily intensifying district efforts to have all teachers rely primarily on FOSS.

Immersion social resource development. As noted, there was no evidence of social resource development associated with the immersion initiative at Baxter Elementary.

School Capacity-Building: FOSS

In contrast to immersion, after LAUSD adopted FOSS in the summer 2007, the district made a concerted effort to provide initial PD to most Grade 4 and 5 teachers. Baxter interviewees reported that virtually all Grade 4 and 5 teachers attended 3 days of FOSS training for their respective grade levels in SY 2007–08. FOSS training days were dispersed throughout the year, with each session focusing on how to use the FOSS kit for a given science component (i.e., Life, Earth, or Physical Science) at a given grade level. SLTs received additional FOSS training during monthly SLT meetings. Schools allocated significant funds to hire substitute teachers to release staff for FOSS and SLT PD.

FOSS kits were initially purchased for schools by the district, but schools used their own funds to replenish them. Baxter had received three sets of FOSS kits for each science component at Grades 4 and 5. B-SLT4, B-SLT5, and B-AP found this to be adequate, but not ideal. As noted below, the Grade 5 team had decided to cover the three science components in the same order across classrooms. This meant each of the three kits for each component had to be shared by two of the team’s six teachers. Much SLT time was devoted to kit management and coordination. B-AP also noted that kits contained only sufficient numbers of student materials for students to do hands-on activities in groups. She firmly believed in the power of hands-on experience and that children would benefit most from FOSS if each student had their own materials to manipulate.

The district investment in FOSS kits and PD, a district memo instructing elementary schools to teach science 100 minutes per week, and rising state accountability pressure for science led to increased attention to science by Baxter administrators. Consequently, B-Prin regularly checked with SLTs to make sure the FOSS kit materials were complete, and asked SLTs to dedicate team meeting time to helping all teachers use FOSS effectively to raise student performance on standardized assessments. B-SLT4 described attending to FOSS in team meetings.

> I: Do you and your grade-level colleagues have a common planning time?
>
> R: Yes, on Thursdays we have staff development for our grade level specifically.
>
> I: Is science discussed at those common planning meetings?
>
> R: Yes, we discuss the opening of the kits—also the development of how to implement the different science experiments throughout the three units of science…. I try to get my … grade level, to do the experiments themselves … by modeling experiments. There is discussion of the assessment, and we try to develop some ideas on how the students can do better on the next assessments.

All Baxter interviewees indicated that the amount and uniformity of science instruction had increased in the school under FOSS. However, they also noted that the biggest changes were at Grades 4 and 5, attributing that mainly to teachers in those grades feeling the greatest pressure about student performance on the state Grade 5 science assessment. B-SLT5 described how her team's use of FOSS was affected by the state test, as well as a desire to coordinate science and ELA instruction where possible.

> R: Actually we start out with Earth Science because it coincides with a unit that we have for Open Court [the reading/ELA curriculum] that has to deal with the solar system. So we start out with Earth Science and then we move on to Physical Science because Physical Science is the most difficult one so we want to have the time. We want to make sure we don't run out of time before CST [California Standards Test]. We want to get the Physical Science in and be able to do all of the experiments and everything with Physical Science and that's the one that the students have the most difficulty with. And then we move on to Life Science, which is the most comprehensible for the students. So we do Life Science lastly because it's easier to move that one along faster before we get to the CST.

FOSS became central to school efforts to marshal resources for human and social resource development. This was evident in B-AP's characterization of the SLT role as formulated in 2008.

> The science lead teacher ensures that our teachers at the school site have all necessary supplies, all science kits are kept full, and they assist all teachers with any understanding of investigations and expectations. They also attend science PD and bring information back and disseminate back into the grade levels.

The priority given to FOSS was further evident in B-AP’s response to a question about what curricular materials were most used by teachers as of 2008.

> The district has developed a district-wide science program; the FOSS Science System is the program that has been adopted. Scientific progress is made by asking meaningful questions and conducting careful investigation and experiments. Students should develop their own questions and perform investigations and/or experiments.

On a related note, B-AP said:

> When our teachers plan together, they work collaboratively; so when they do, they bring their science instructional guides so that all the students have equal access to the same curriculum. As you go in and out of the different classrooms, you will see similar lessons being taught…. I’m very excited about what I’m seeing regarding science in particular because the students seem to be more motivated about performing the science investigations and learning about the processes.

Other Baxter interviewees expressed similar views that teachers were moving toward an increasingly shared understanding of their science curriculum and instructional practice, with one important qualification: Progress was much slower in Grades K–3, and B-SLT4 said as much.

> I: Do you think there is a clear vision for science teaching and learning at Baxter Elementary?
>
> R: For the higher grades, I think there is. For the lower grades, I think there are still some loopholes…. Higher grades, third grade, fourth and fifth, there is a clear vision of what we want.
>
> I: So in your opinion, what is that vision?
>
> R: The vision is, of course, the California Standards Test in science. We need to … make sure that the students are progressing every year. Of course, then, making sure that all the kits are being used and the science experiments are being done so that the students get the experience of hands-on science experimentation.

Indeed, both SLTs and the principal noted with pride that the school’s science scores had risen steadily in recent years.

Summary

Contrasting school actors’ perceptions of the organization’s experience with immersion and FOSS provides important insights. For reasons perhaps known only to the principal in place at the time, and whom we did not have an opportunity to interview, Baxter passed on the initial invitation for the school to engage systematically in the immersion initiative. Yet, the school demonstrated considerable capacity to pursue instructional change in science when the district context supported it, as it did with FOSS.

Research by Porter and others (Porter, Floden, Freeman, Schmidt, & Schwille, 1988; Porter, Kirst, Osthoff, Smithson & Schnieder, 1993; Osthoff, 2003; Desimone, Smith, & Phillips, 2007) shows that policy initiatives are effective to the extent that they are powerful (i.e., supported with material resources), authoritative (i.e., backed by expertise, legal force, charismatic leaders, or traditional beliefs and practice), specific (i.e., about the nature of desired practice), and consistent (i.e., with signals contained in related policies.) From the perspective of Baxter teachers and administrators, such conditions characterized the FOSS initiative much more so than immersion. The district put up substantial funds for FOSS materials and PD, and perceived clear guidance from the local district and school administrators about how to organize for FOSS implementation, and sufficient guidance about what FOSS teaching and learning should look like. They further found that science instruction based on FOSS kits could be more or less squeezed into available science instructional time. All these factors came through in the extent and purposefulness of school actors' individual and collective efforts to coalesce around FOSS as their core curricular material.

In the next vignette, we see how actors in a different school sustained significant immersion use at the same time that they converged on FOSS as their primary curricular resource.

Hernandez Elementary

Hernandez illustrates two different variations on partial immersion implementation. This includes a Grade 4 teacher who used RIR heavily, in isolation from her grade-level team, and a Grade 5 team that integrated substantial portions of the Grade 5 *Weather* immersion unit with the FOSS Earth Science kit on weather. A caveat for this vignette is that it is difficult to separate the discussion of immersion and FOSS human and social resource development because district PD institutes encouraged and modeled the blending of the Grade 5 immersion *Weather* and FOSS Earth Science units. Hernandez Grade 5 teachers did in fact thoroughly integrate the two curricula, making it difficult to discern whether immersion or FOSS was the focus when teachers planned and implemented their Earth Science instruction.

With just under 1000 students in 2005–06, Hernandez is smaller than Baxter, yet still had 20% more students than the sample mean. This includes five teachers each at Grades 4 and 5, a very high percentage of students on free and reduced-cost lunch (87%) and minority students (97%), more than 40% of whom were ELLs. Hernandez, made Adequate Yearly Progress in 2005–06, but not 2008–09.

Immersion PD Participation and Unit Implementation

District PD attendance records show that no Grade 4 Hernandez teacher attended a 5-day immersion institute. However, H-SLT4 did attend a 2-day immersion training facilitated by a local district expert in 2006. Subsequently, H-SLT4 taught RIR largely in its entirety in school years 2006–07, 2007–08, and 2008–09. It is interesting to compare H-SLT4's immersion experience to that of the school's Grade 5 teachers. H-SLT4 became an instant and full adopter of immersion, then attempted without success to convince the rest of her grade-level team to attend immersion PD in SY 2006–07, her first year as SLT.

The Grade 5 team fully integrated immersion and FOSS under the guidance of H-SLT5, whose science instructional leadership appeared unmatched by any other school actor in our interview sample. PD attendance records show that one Grade 5 Hernandez teacher attended the immersion institute in summer 2007, three participated in summer 2008, and one teacher went both years. This represented the highest immersion PD participation rate of either vignette school grade-level team. H-SLT5's remarks on how she and her team approached the integrated immersion and FOSS weather units provide a sense of the extent of implementation.

> I: What did you want your students to take away from the Earth Science instruction that you provided?
>
> R: Understanding of standards. And hopefully they'd have an understanding of the water cycle and the weather systems. And what a meteorologist does.
>
> I: So that was the learning goals you had—that they'd understand the water cycle, weather systems, and what the meteorologist does?
>
> R: Yeah. And they did weather reports in groups. We didn't do every single lesson of the immersion unit, but we did a good part of it and it ended with the weather report [activity, which we] did.
>
> I: So what curricular materials did you primarily rely on for science?
>
> R: Well I used both water planet and the immersion unit. The weather forces and predictions. Yeah I used both.
>
> I: Both equally?
>
> R: It was about half and half, yeah. It's hard to get it all in. I did as much as I could of both…. There just wasn't time to do everything, so I had to skip a few lessons here and there.

H-SLT5 said PD institute facilitators told the teachers that there was not time to teach every lesson in a merged immersion/FOSS unit and provided written notes on which lessons were most important and which could be omitted. H-SLT5 said she largely followed this advice when implementing.

Baseline School Capacity

Baseline material resources. H-Prin reported that Hernandez had provided only modest material support for science instruction in recent years. She noted that the district had sent earlier versions of FOSS kits to the school prior to providing significant PD, and the kits were put in storage and went unused for a year or more. She said science PD levels were low until 2006–07, when the district launched FOSS once again, but in earnest, while continuing to provide immersion institutes. The school relied almost entirely on the district to carry the science PD load because the vast majority of school PD time targeted math and reading/ELA. H-Prin's approach to PD was typical.

> I: In your school, how much priority is given to science compared to other subjects and why is that?
>
> R: Not much. We do not have PD lined up for science because our concentration has been heavily in language arts and mathematics and primarily for our English learners because those are the areas we're tested on other than fourth and fifth grade.… [T]hey are tested in science, but it doesn't factor [into] our API [California's Academic Performance Index for schools] and AYP [the federal Academic Yearly Progress].

In requiring Grade 5 science testing but not factoring it into the school performance scores upon which accountability sanctions were meted out, the state and federal government made science achievement public enough that schools could not ignore it, but not consequential enough to compete with math and reading/ELA for the organization's resources.

When state funding took a nose dive in 2008–09, district resources for science tightened up and SLT funding took a hit. H-SLT5 continued in the role but with responsibility for Grades 4 and 5. It appears that her support for teachers in Grades K–3 was limited to FOSS materials coordination. This entailed little work as K–3 teachers did not teach science or use the kits much.

Baseline human and social resources. Interviews suggest teachers were not given joint planning time for science prior to immersion and FOSS, but the data show that teachers did use joint planning time for science beginning no later than SY 2007–08. Interviewees noted that science instruction in Grades K–4 varied greatly prior to immersion and FOSS.

On survey measures of organizational capacity (Hanselman, Grigg, & Bruch, April 2010), Hernandez scored low on *Institutional Support for Teaching*, and very low on *Principal Leadership* in 2006, but bounced back on both measures in 2008. Despite the fact that Hernandez interviews suggested that H-SLT5 provided strong leadership for science, the school as a whole scored considerably below the sample mean on *Teacher Leadership* both years. Hernandez had low teacher turnover in Grades 4 and 5 in the years preceding and during the SWC study. H-SLT4 had 10 years of experience in the school, and H-SLT5 had been there for 5 years. The data suggest that the Grade 5 team had a habit of collaboration that may have extended to science prior to the immersion initiative, but the Grade 4 team probably did not.

School Capacity-Building: Immersion

Immersion material resources. H-Prin indicated that the immersion initiative occasioned no change in how she allocated resources for instructional support. The one resource afforded teachers by the school was encouragement by the principal to use some grade-level meeting time at the beginning of the year for long-range science instructional planning. Remaining resources for inquiry-science curricula and PD came entirely from the district and SCALE partnership. Teachers saw the local district science expert as their gateway to PD opportunities and curricular materials and supplies needed for immersion implementation. More than anyone else, Hernandez Grade 5 teachers took full advantage of their expert's support.

Both SLTs indicated that much of the time they dedicated to the SLT role was consumed by FOSS-kit management and assessment logistics. However, H-SLT5 appropriated more than the usual amount of grade-level meeting time to focus on inquiry science, even if that was not actively encouraged by the school.

Immersion human resource development. As with material resources, much of the school's access to human resources for inquiry science resided in their local district PD activities and expert. H-SLT5 was highly appreciative of her local district expert's impact on her understanding of science teaching and learning.

> I: How about your local district science expert?
>
> R: He's great. I love [him].… [T]he trainings that he leads are really good and they always inspire me to go back and do more in my classroom…. It might help me see things in a different way or a different approach I can have with my kids. I can take it to the next level with science notebooks. I always get good ideas from [his] trainings.

Both H-SLTs were highly positive about the immersion PD in which they had participated. H-SLT4 recalled,

> The most important thing I learned from the training [was] how to carry out the experiments so that I could do them in the classroom with the children. It was very hands on. And the material was very interesting to learn…. It actually gets me excited about teaching Life Science, I must say. I get more excited when it comes to teaching Life Science because of *Rot It Right* than I do about teaching rocks and minerals and electricity and magnetism using the FOSS kits, I have to say. I just wish the district would push for the *Rot It Right*. That was one of the best decisions I've made myself to, you know, attend the PD on my own without anybody telling me.

It seems H-SLT4 felt immersion PD provided her with pedagogical content knowledge needed for effective classroom implementation.

Although most teachers found immersion lesson prep to be more labor intensive than FOSS, H-SLT4's view was just the reverse.

> The [*Rot it Right*] materials haven't really changed. I just follow the instructions in the immersion unit and I buy the seeds, I ask the students to bring, you know, plastic water bottles. And we cut them and, you know, I bought the wick so that, you know, and the dirt. I actually like *Rot it Right* much better than the FOSS, which I am not too crazy about, I have to admit—sending the cards, you know, for the live animals that we're supposed to keep. You know a fish and this and that. And the poor animals end up coming dead and, you know.

H-SLT5 was more was more typical in feeling as though immersion lessons required a lot of prep time.

> R: It is a little bit hard to manage as far as planning and figuring out copies. That takes some time to figure out exactly what you need for each lesson. It's not super clear and easy.
>
> I: You mean like the materials?
>
> R: Materials, yeah.
>
> I: So that wasn't clear in the actual binder?
>
> R: You get a big binder. I mean it does have a yellow sheet that tells you what you need but even there you have to spend some time planning each [activity]. Okay I need to go find this sheet, I need four copies of this, one for each group, or I need one for every student, or I need half sheets of this. It's pretty time consuming to figure out. It's just a little hard to use. But it's still a good [unit]. I don't *not* do it. I do it. You know what I mean?

Lesson prep demands aside, both H-SLTs felt their students found their respective immersion units to be engaging and that the immersion approach worked well for them as learners.

> H-SLT5: The immersion unit I really like because there's a clear goal to it and a product that's created by the students and they have an understanding of predicting weather. It's a fun project for them to do. I videotape it and we showed it at open house.
>
> And,
>
> H-SLT4: Ever since I went to the training for *Rot It Right* I really enjoyed it so that's what I've been using in my classroom and [my students] get very excited about it; with the experiments of the terraqua columns and everything. I think [students] have a better understanding … and it seems to be easy for them to make the observations of what's happening to the [columns] that are in the sunlight and the ones that are hidden in a box in the dark. And, you know, they enjoy that process, the entire thing, they do.

H-Prin, a former elementary teacher, was less concerned with what she saw to as small differences between immersion and FOSS than about the challenges she believed any hands-on, inquiry-oriented curricula posed for many teachers.

> [Teachers] don't feel confidence teaching science and the kits are scary to them. So there's so many components to each kit that they don't have the time to take the video home. They don't have the extra inspiration to take the video home to learn about each kit, to teach it in their classroom and teach it well.

Immersion social resource development. H-SLT4 set out to have an impact beyond materials coordination when she served as SLT in 2006–07. For the first time during her 10 years in the school, the Grade 4 team came together, at H-SLT4's behest, to collaborate on long- range science planning before the school year started. This resulted in all five team members teaching the science components in the same order so that they could informally compare strategies and ideas as they proceeded. Unfortunately, when there was no district funding for a Grade 4 SLT in 2008–09, the joint planning for science stopped and teachers quit teaching the components in the same order.

Although H-SLT4 said she tried repeatedly to convince her colleagues to go to the *Rot it Right* PD institute and implement the unit with their students, there were no takers.

> I've tried to tell them about *Rot It Right*…. [I]t's not that they're against it. It's not that. It's just that … for them it may be more convenient to do [FOSS] just because they can grab the box and take it to their classroom. But, you know, for me to [get them to try immersion] I have to give 'em all the information from the binder and everything. At the beginning of this year I had a teacher who was almost going to do it and then, I don't know what [happened], and she ended up…. I guess she did FOSS.

Despite efforts to generate some structured collaboration around science H-SLT4 said things had reverted to the point where, "I just work on my own, basically."

In contrast, the Grade 5 team made significant if modest strides in forging social resources around science. H-SLT5 described aspects of grade-level team collaboration in response to a question about how she has affected the science teaching of others in her role as SLT.

> R: Hopefully I've inspired them to teach science more consistently. I mean I can't make them teach science you know. My grade level pretty much does. I'm not so sure about some of the other grade levels. [Our team does] grade-level planning at the beginning of the year and we … teamed up to see which two teachers would be teaching the same strand at the same time so we could kind of partner up as far as planning lessons and that sort of thing. So that organization, I think, helped keep us on track.
>
> I: Did you lead that as science lead teacher?

R: In a loose sort of way. We collaborate all the time. And we did it for every subject. But I kind of organized that and we have video tapes and I organized those, which ones would go with which subject. And we've had a little checkout system here in my room.

I: Per science subject?

R: Yeah per strand: Earth Science, Life Science, Physical Science.

I: Okay and what about as far as how science is taught or what science is taught. Have you affected the science teaching of others in your role as science lead teacher as far as strategies with the use of inquiry and immersion?

R: Not really because other than teaching the FOSS kits and kind of organizing how they're going through the classrooms, we haven't had any, kind of been given any time to meet about science.

H-SLT5 wished the team had more joint planning time to address substantive instructional issues in science. For example, she thought they could benefit from discussing their district and state science assessment scores as a team, identifying areas for improvement, and brainstorming strategies for more effective instruction.

School Capacity-Building: FOSS

Although most teachers found implementation logistics to be less extensive for FOSS than for immersion, FOSS implementation was far from automatic. H-Prin recounted the school's history with FOSS, going back to the district's rollout of an earlier version of FOSS kits without the benefit of PD.

R: Our district has gone from a textbook approach to more of a hands-on with the FOSS kits. I think those came much [too] prematurely compared to the PD. All the schools were given, [on the] spur of the moment, FOSS kits. Thousands and thousands of dollars were spent on these FOSS kits without the PD. So they did sit for a year to 2 years and now the PD is catching up to the kits.

I: They were in [storage] outside for a couple years?

R: Mmhm. Brand new. And many [unused FOSS] kits were already in that bin from the previous year or two when the district decided to go that route. And they replaced them again because the FOSS kits were realigned to standards-based instruction. So they were sent to all the schools without the schools knowing they were coming a couple years ago. So they got housed until we could figure out how to inventory them and throw out the old or condense the two kits…. The PD is finally catching up to that.

I: So for a while you had FOSS without the PD and they just sat.

> R: Mmhm.
>
> I: And now that there's PD, it really is changing from textbook only—
>
> R: To hands-on experiments.

Even though the district had pushed for teachers to take part in up to 3 days of FOSS PD (i.e., 1 day for each grade-level science component/FOSS kit) in the summer of 2008, FOSS implementation in 2008–09 was far from widespread. This was especially true in grades K–3, where the principal said she did not push hard for FOSS implementation but only encouraged teachers to "get their feet wet" by using at least some of the lessons in one kit during the year. She noted that Grades 5 had made the greatest progress with FOSS implementation, further believing that was due in part to accountability pressure at Grade 5 and the renewed district and school emphasis on FOSS in the upper elementary grades.

> R: The fifth grade team seems to be doing a better job at [FOSS implementation] because they collaborate with each other for planning and bouncing ideas on how to get the skills across…. Plus, that's the grade level that's tested. Even though they're tested on fourth and fifth grade skills, and I'd say this is the second year we really pushed all of our fourth grade teachers to use FOSS [so that] the kids [would be] more familiar with it once they reached fifth grade, [and therefore] it [wouldn't be] new to them.

H-Prin felt increased PD support "made a huge difference" in FOSS implementation the second time around, even if not all teachers participated or followed up by using FOSS in the classroom.

> I: Okay. Does this district or local district influence the priority given to science?
>
> R: They had a pretty strong team this year and they offered a lot of professional development with the FOSS kits and they paid for the substitutes to release teachers to go to the PD, which was wonderful. I would say more than half of my staff this year took advantage of at least one of those PDs and a couple teachers went to two different trainings.

Teachers such as H-SLT5 who did implement FOSS observed that students found FOSS—by itself or combined with immersion—to be substantially more engaging and educative than traditional textbooks.

> I: [What are the strengths and weaknesses] of the FOSS water planet kit?
>
> R: Well strengths are definitely that it's hands on, the students have fun with it, they're doing investigations, they're following the process of inquiry. The difficulties would be managing the materials, the time it takes to set up, the time it takes to do the investigations when we're really pressed for time.

> I: Looking back on your science teaching for the last few years, what if any significant changes have you seen or experienced?
>
> R: I think … when you use the hands-on materials, students are more engaged and they look forward to doing science, whereas if you were just using a textbook they don't want to do science.
>
> I: Okay, and so how has that changed over the last few years?
>
> R: Because we adopted the new FOSS materials, and we have the new FOSS textbook, which is closely tied into the investigation, so when they read it it's not just reading about something they have no connection to. [T]hey're reading about something they've done. So it's more real for them.

As noted at the beginning of the Hernandez vignette, it is impossible to disentangle the impacts of Grade 5 FOSS and immersion PD and curricula because by the summer of 2008 the district and MSP partnership had merged the two. This immersion-FOSS hybrid was embraced by teachers because, despite implementation challenges, they felt it worked well for their students.

Unfortunately, with further devastating budget cuts pending at the time the 2009 interviews were being conducted, there was widespread uncertainty and pessimism about the ability of schools to sustain and build on recent gains in science instructional capacity in the coming years. H-Prin had this to say.

> I: Over the next several years, do you expect the importance of science teaching and learning in LAUSD and/or your school to rise or decline, and what makes you say this?
>
> R: I would say it's going to decline because the local district support is no longer there. They've dismantled that department. So the PD will not be available to teachers, the funding will not be available to purchase the refurbishment kits, so, in my opinion, it's probably gonna go back to textbook learning for science, eventually.
>
> I: Does that mean that the importance of science teaching and learning declines?
>
> R: Not the importance of it, no. I don't think the emphasis is gonna be there from the teachers because the resources won't be available to them.

H-SLT5 was similarly pessimistic.

> I: Over the next several years, do you expect the importance of science teaching and learning to rise or decline, and what makes you say that?
>
> R: I expect it to decline. Not in my classroom, but overall because of budget cuts and less professional development. Less opportunities to learn how to teach science in the

> classroom. When there were a lot of science activities going on I think there was hope that more teachers would become involved in it.
>
> I: Okay. Do you expect support for science teaching and learning to rise or decline in the next few [years], and what makes you say that?
>
> R: Support financial support or support?
>
> I: Support however you want to define it. You already said PD support would decline. And that was because of budget cuts?
>
> R: That would be my guess, because there's already been fewer [PD offerings] this year than in previous years. It probably also depends on ... what happens with our test scores because if we don't meet our API then we're going to be focusing more on ELL and language arts and raising test scores there—other things [will be] de-emphasized.
>
> I: You mean like science might be de-emphasized if you don't meet your APIs?
>
> R: Mmhm.
>
> I: Any other kind of support that you see rising or declining?
>
> R: Well, we may not have a science lead teacher at all next year. I don't know what's happening with that…. I've just heard that it's not sure whether that's going to be in the budget or not. I don't know.

The one glimmer of hope in H-SLT5's remarks is that there might be pockets of teachers who, having already participated in district PD for immersion and FOSS, might have the foundation needed to engage students in inquiry science in the absence of further district support. However, that would be little consolation to the tens of thousands students in other LAUSD elementary classrooms where science might continue to be ignored or taught ineffectively.

Hernandez Summary

Grade 4 immersion implementation at Hernandez illustrates a common pattern in the larger sample of a highly enthusiastic immersion adopter teaching the unit in isolation from others. Grade 5 immersion was implemented more broadly due to its integration with the mandated Grade 5 FOSS weather kit. Overall FOSS implementation was fairly robust among teachers in Grades 4 and 5, where accountability pressure was significant. Implementation in grades K–3 was spotty at best.

Immersion and FOSS implementation at Grades 4 and 5 was impeded by what teachers perceived to be high demands on teacher lesson preparation and the fact that the time needed to teach inquiry science lessons generally outstripped the amount of available instructional time. Constraints on science instructional time were enforced by the district and school principal in order to intensify efforts in math and reading/ELA—the subjects associated with high-stakes accountability.

Attempts by H-SLT4 to foster social resource creation in her grade-level team around immersion in particular and science in general fell flat. The Grade 5 team members exhibited meaningful collaboration—perhaps investing somewhat more time in science planning and coordination than their principal might have liked.

Hernandez actors suggested that implementing immersion was more demanding than FOSS and thus required greater teacher commitment. The presence of such commitment was forthcoming among teachers who attended immersion PD. However, most Grade 4 teachers declined to go to immersion PD because it was not mandated and required 5 days compared to only 1 day for an equivalent FOSS unit.

The resource framework appears up to the task of helping to understand many of the differences in how teachers responded to the district immersion and FOSS initiatives. Any individual teacher who attended a 5-day immersion PD institute tended to receive a higher level of support for that curriculum than what the teachers typically received in connection with a FOSS kit. However, a greater proportion of teachers received FOSS training, and teachers seemed to be willing to attempt FOSS implementation on the basis of the much lower level of training.

Teachers who went to the effort to implement either curriculum were pleased with the results. Yet, teachers and the principal alike were concerned that pending cuts in district support for science would make it difficult to sustain robust inquiry science in the future.

Vignette Summary

Six generalizations characterize the two vignette schools.

1. District policy guidance and program support substantially influenced the response of vignette schools to inquiry-oriented reform generally, and immersion reform specifically.
2. When allocating organizational resources, principals in vignette schools adhered to district directives to prioritize math and reading/ELA over science teaching and learning.
3. Principals frequently accommodated the predilections of individual teachers in making decisions about organizational support for science. Teachers who expressed special commitment to science frequently received enhanced levels of material resources for science PD and instruction, and were much more likely to be SLTs. Teachers who wanted to minimize or eliminate science instruction were tolerated.
4. Teachers who attended immersion and FOSS PD and subsequently implemented it observed that students found the inquiry-science materials to be highly engaging and supportive of learning.

5. SLTs varied in the degree to which they defined their role—either to focus narrowly on logistical matters, or, more broadly, to include instructional leadership. SLTs who conceived their role broadly had some success affecting their principals' broader allocation of resources to science, and in cultivating human and social resources within their grade-level team.
6. Comparing the immersion and FOSS initiatives confirms the above generalizations while also further suggesting that important differences exist between the two reform initiatives in terms of the specific human and social resources required of school actors for successful implementation. For example, many upper elementary teachers attempted FOSS implementation based on only one day of PD per FOSS kit. In comparison, it appears a lower percentage of immersion PD attendees attempted immersion implementation, and those who did often implemented only part of the unit and did not attempt to teach it a second time. Higher immersion use at Grade 5 resulted from the district and partnership having merged the immersion and FOSS weather related units. Teachers appreciated district guidance about what lessons a teacher might safely omit when teaching the merged unit.

Conclusions

This paper analyzes complex interactions among district context, school capacity, and reform initiative vision and design by using an organizational resources framework within a dynamic model of organizational development to bring attention to important dimensions of instructional reform for inquiry science. We argue that reform initiatives progress most fruitfully when there is high alignment among a district's instructional support activities, a school's baseline stock of human and social resources for science instruction, and the specific characteristics of the envisioned reform initiative—especially the vision of teaching and learning embodied by the intervention. Stated another way, the motivation and ability of school actors to adopt and systematically engage in district-initiated instructional reform depends upon the degree of fit between their initial school capacity and the specific capacity demands of the intervention in question.

In the context of LAUSD, the match between district and school capacity and reform type was consistently better for FOSS than immersion. Those who strongly hold the ideal of intensively student-centered inquiry science, including the present writers, can argue that the immersion initiative would have been more successful if only the district had used a more forceful set of policies and implementation activities to foster school adoption and success. While containing a grain of insight, the observation misses the mark on at least two critical levels. One, the immersion approach to teaching and learning represented a huge change not only for school actors, but also for most district actors and SCALE partners from colleges and universities. Second, even if the district and SCALE partnership had poured many times more resources into immersion dissemination and support, it might only have resulted in resistance from schools for whom the vision seemed unrealistically ambitious, or even misguided. In an era when policy analysts and organizational managers are highly attuned to the issue of sustainability of instructional innovations, it is important to recognize the dramatic spike in capacity and resource demands for innovations for deep change in core instructional practices.

There is evidence that the immersion initiative successfully enabled a significant but relatively small number of teachers to move from their baseline capacity to possessing a level of knowledge and commitment to immersion to embark on classroom implementation. However, progress toward quality implementation was slow going, and little was done to allocate school site resources to increase the breadth or depth of immersion implementation.

FOSS represented a better fit for LAUSD in the sense that it was closer to the science instructional capacity profile of most schools, involved a level of district resources that could be more or less mustered, and provided a strategically viable way for the district to respond to state and federal accountability and state constraints on resources for curricular material funds embodied in their textbook adoption policy. In essence, FOSS represented an inquiry instructional improvement strategy that might not ever move instructional practice as far as immersion could, but much of the change it sought might be realized relatively quickly with available organizational resources.

There is a discomfiting quip that makes the rounds in policy circles to the effect that standards-based reform for student understanding is a great idea; we should try it some time. In the immersion initiative, many LAUSD and SCALE actors made a genuinely heroic attempt at implementing an exceptionally ambitious form of student-centered inquiry science. Considering how the size and complexity of LAUSD dwarfed district capacity for reform at the outset, these educators achieved meaningful, if isolated, success.

From an organizational development perspective it is perhaps more realistic for large districts such as LAUSD to get up to speed on a curriculum like FOSS rather than immersion. Though both emphasize inquiry science, FOSS limits the amount of PD needed for rudimentary implementation by providing highly specific teacher guidance for lesson delivery. Teachers who rely fully on the instructional scaffolding in FOSS can get started quickly with the curriculum while improving their facility over time as they garner first-hand experience using it with students. Though systematic evidence is not available, several LAUSD teachers and science experts suggested that teachers who had engaged fully in immersion PD and implementation possessed a conceptual grasp of inquiry science that enabled them to appreciate FOSS more readily, and had instructional strategies that made the inquiry in FOSS more student centered than the typical textbook. Similarly, FOSS might be a good stepping stone for any school or district that wants to attempt student-centered inquiry science curricula, such as the *Rot It Right* and *Weather* immersion units. Ultimately, the fact that immersion was not a wall-to-wall curriculum and not on the state list of adopted materials probably would have hampered sustainability in any case. Yet, had LAUSD begun the immersion initiative with a better foundation of material, human, and social resources for inquiry science, it might well have achieved broader and deeper immersion implementation, and thus a more definitive test of the promise of highly student-centered inquiry science curricula.

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Appendix 1: System-Wide Change Study Interview Codebook

Context: *Aspects of classroom/school/district/community/state/national environment that shape important practices and the meaning or significance of such practices. Generally includes factors affecting classroom, school and district practice and which are primarily not under the control of the teachers and district people (e.g., student demographics; school funding levels; state and district mandates, especially for assessment and accountability.)*

Level: Level of educational system

- **Nation:** *Reference to National Institution or org.; e.g. Federal Gov., NSF, Dept. of Ed, National Professional Org, etc.*
- **State:** *State level ed. org. (e.g. State Dept. of Ed) identified as directly or indirectly affecting Elementary Science in LAUSD, especially Elementary Science Immersion (does not include IHEs, which have their own node.)*
- **District:** *LAUSD Central Office/District as a salient organizational context for activities, policies, and practices related to Elementary Science Curriculum, PD, and implementation.*
- **District Science Team:** *The group convened and facilitated by Central Office Science Administrators to coordinate Elementary Science across Local Districts. Includes Local District Science Experts when they are acting at least partly in the context of their membership in the District Science Team.*
- **Local District:** *Local District as a salient organizational context for activities, policies, or practices related to Elementary Science Immersion in LAUSD.*
- **School:** *School as a salient organizational context for activities, policies, or practices related to Elementary Science Immersion in LAUSD.*
- **Grade Level:** *Grade Level as a salient organizational context for activities, policies, or practices related to Elementary Science.*
- **Classroom:** *Classroom as a salient organizational context for activities, policies, or practices (including informal policies) related to Elementary Science or Elementary Science Immersion in particular.*
- **IHE:** *(e.g. California State University-Dominguez Hills) as a salient context for activities, policies, or practices related to Elementary Science (especially Elementary Science Immersion) in LAUSD.*
- **Partnership:** *i.e., The SCALE partnership, responsible for bringing immersion units PD institutes to LAUSD.*

Role

- **Teacher**
- **Lead Teacher:** *Teacher charged with supporting instruction of others in the school (e.g., SLT).*
- **Student**
- **ELL Student**
- **Expert:** *Science instructional support person. Experts are local district role group most directly responsible for providing teachers with instructional support, including Science Immersion PD (includes Science Specialists, Science Experts, MST Specialists.)*
- **Administrator:** *Any LAUSD administrator, including school principal or assistant principal. Does not include Lead Teachers, Science Experts, or MST advisors.*

Domain

- **Classroom Instruction**
  - **Pedagogy:** *Teaching methods and activities.*
  - **Classroom Management:** *Teacher classroom practices supportive of but not directly entailing*

academic instruction (e.g., management of materials, movement and behavior of students.)

Curricular Content: *The academic content of instruction, including topics and the level of understanding at which they are addressed.*

Pacing: *The actual or intended rate (or order) of coverage of curricular content.*

Lesson Planning/Preparation: *Teacher work related to preparing to deliver instruction (e.g., producing/organizing instructional materials; reviewing and adapting instructional materials (e.g., worksheets, texts, teachers' guides) for own students or instructional approach.*

Other classroom: *Other aspects of classroom life affected by or related to inquiry science or science PD.*

Instructional Support

Professional Development

Design: *PD as intended; includes intended goals, methods, facilitator roles, impact on level or distribution of human and social resources (including impact on participant content and pedagogical knowledge). Also includes PD model (i.e. the instructional design (e.g. conceptual flow and participant roles) of the PD itself as opposed to the immersion unit or other science. Will often be double-coded with "Vision."*

Delivery: *PD as enacted. Reference to actual activities and events that occurred during PD, or actors' perceptions and interpretations of such things.*

Logistics: *PD Logistics. Includes PD staging matters such as PD time and location, facilitator selection, materials preparation, stipends, etc. Note: Logistics related to PD recruitment are in child node below.*

Recruitment: *Recruitment of schools/teachers for participation in Elementary Science PD (especially Immersion PD) or the System-wide Change Study.*

Technical Assistance: *Technical assistance for science teachers. May include help with technology or materials.*

Non-Instructional Support: S*upport given to teachers that is not directly related to classroom instruction.*

Instructional Approach: *Includes, especially, immersion and inquiry science as distinctive instructional approaches.*

Inquiry: *Instructional approach that emphasizes student inquiry (e.g., hands-on or minds-on discovery learning) as compared to approach in which teacher is dispenser of received disciplinary knowledge. Includes (and is double-coded with) references to Science Inquiry Features in national or state standards.*

Immersion: *Immersion as an approach to science teaching and learning. Includes, especially, references to the instructional model (e.g., Engage-Explore-Explain), conceptual flow (e.g., students beginning with concrete and working toward abstract through cycles of inquiry), and student metacognition (e.g., focus on making connections among emergent concepts and facts as way to scaffold student understanding as they progress.)*

Other Instructional Approach: *Instructional approaches other than Inquiry or Immersion (e.g., Traditional approaches.)*

Curricula: Instructional materials that represent an instantiation of intended curriculum.

Immersion

Grade 4 Rot It Right: *The Grade 4 "Rot It Right" Immersion unit used in LAUSD.*

Grade 5 Weather: *The Grade 5 "Weather" Immersion unit used in LAUSD. Note: to be double-coded with 'FOSS' in instances where it is clear that unit incorporates elements of each.*

FOSS

Grade 4 FOSS: *Grade 4 FOSS materials used in LAUSD.*

Grade 5 FOSS: *Grade 5 FOSS materials used in LAUSD.*
Other Curricula: *Curricula other than Immersion or FOSS.*

Other Discipline: *any discipline other than Science.*

Vision: *General views of a thing (e.g. PD model or initiative, curricula, instructional approach, role) often including perceived purpose, desired relationship to other things (e.g. desired effects of PD on instruction).*

Definition: *Definitions of things (e.g. Inquiry, Immersion, roles (e.g. SLT, Science Expert). For roles, includes the attitudes, values, behaviors expected for the role.*

Strategy: *Strategic considerations related to the actualization of Theory of Change. For example, the formation of a District Science Team in LAUSD was a strategy for facilitating coordination between the Central Office and Local Districts in an organizational structure that had a particular division of authority and labor between organizational levels.*
Equity: *Equity of student and teacher access to material, human, and social resources.*

Innovation: *Reference to special considerations in implementing policies or practices due to newness of policy or practice.*

Policy Tools: *May include formal or informal national, state, district, school, or classroom policies. Common tools include assessments, standards, accountability, and curricular materials (as a general class of things, not specific curricula).*
Standards: *expressing actual or intended alignment with state standards.*
Assessment & Accountability: *Assessments and related accountability policies and practices.*
Other Policy Tools

Coherence: *Consistency or complementarity of elements of the science instructional system, include curriculum, professional learning, accountability, etc.*
Alignment: *Level of agreement of academic content across curricular instantiations such as standards, assessments, curricular materials, enacted classroom curriculum, etc. Also includes articulation of content across a course, classrooms, or grade levels.*

Resources
Material: ***The 'things' teachers need to teach, e.g. money, anything money can buy, physical infrastructure, curriculum, electronic information; can be exchanged among groups as materials or information.***
Money: *Funds from the school, university, grants, etc. that pay for the activities of the professional development group or teaching in the classroom.*
Teaching tools, supplies, materials: *The artifacts used by members of the PD group in their group's activities or in their classrooms. These can include textbooks, lesson plans, props for doing certain exercises, etc.*
Time: *To code presence or absence of time needed to engage in a given professional practice other than professional development. Will often be coded in conjunction with "constraining," such as in situations where there is not enough time to do science instruction because the limited instructional time available is dedicated to math and reading/ELA.*

Professional Development: *Opportunities to meet to work on changing teaching practice and/or develop capacities. This includes PD time to meet to communicate about teaching, coordinate curriculum, learn new material, etc.*

Technology: *Issues or incidents related to the use of computer or electronic technology.*

Professional Knowledge Base: *Information (usually written or in electronic format) that teachers can draw upon to inform teaching in the classroom or activities of the professional development group.*

Distribution of inquiry science material resources: *Includes procedures for distribution as well as intended and actual distribution.*

Distribution Immersion Materials: *Intended or actual distribution of Immersion materials.*

Distribution FOSS Materials: *Intended or actual distribution of FOSS materials.*

Distribution other materials: *Intended or actual distribution of materials other than Immersion or FOSS.*

Human: ***Knowledge, skills, and commitments of educators, e.g. content knowledge, pedagogical ideas/practices, cultural/social understanding of students, beliefs about learning; can be exchanged among groups through overlapping memberships.***

Professional Knowledge: *Ideas, thoughts, skills, and practices used in teaching or that form a basis for teaching.*

Leadership: *Ways in which individuals or groups take charge of activities or provide direction for mathematics and/or science for the professional development group, school, or district.*

Disposition to learn: *Individuals or groups who express a willingness to learn more about a topic. Also, the degree to which a participant expresses an openness to grow or change.*

Uncertainty: *Teachers talking about or experiencing uneasiness or ambiguity in their teaching practice.* (There is ***no ABCON*** version of this code).

Commitment to teaching practice: *Individuals or groups who express a desire to teach in a particular manner. Also, ways in which teachers talk about their philosophy of teaching, the way that they teach, or how they want to teach.*

Attitudes toward Inquiry Science teaching: *Attitudes toward involvement in inquiry science teaching, including Immersion and FOSS.*

Distribution of Inquiry , Immersion, or FOSS Human Resources: *Includes procedures as well as intended and actual distribution.*

Social: ***Attributes of roles, relationships, and communication embedded in social networks of educators, e.g. norms, information flow, common purpose; may be built from material and human resources; are not exchangeable among groups but must be constituted anew within each group.***

Professional Community: *A group of educators who work collaboratively to focus their professional activities on student learning. Key elements include shared purpose, collaboration, collective focus on student learning, deprivatized practice, and reflective dialogue.*

Shared sense of purpose: *Educators' shared beliefs, values, goals for the school, their department, or their classroom teaching.*

Collaboration: *Participants work together to plan, organize materials, and/or carry out instructional activities.*

Collective focus on student learning: *Participants focus collectively on what and how well students are learning.*

Deprivatized practice: *Participants share their teaching practices with one another. This means not just talking about it, but observing or participating in one another's teaching.*

Reflective Dialogue: *Participants discuss teaching and learning. This includes sharing stories about teaching or materials that the teachers or students produced.*

Membership: *Individuals who are included or excluded from the PD group and the ways in which inclusion is determined.*

Administrative support and control: *The role principals, superintendents, curriculum* *coordinators, etc. play in supporting or setting barriers for TFU or the PD group's activities. This includes the quality of the relationships that participants have with administrators.*

Reward Systems: *The ways in which teachers are praised or otherwise compensated (aside from salary and benefits) for their work.*

Professional Standards: *Guidelines used to bound teacher behavior.*

Autonomy: *The freedom and flexibility that teachers have in their jobs, in general.*

Classroom control: *The freedom and flexibility a teacher has to establish norms, expectations, and practice in her/his classroom.*

Influence on school policies: *The degree to which teachers (acting either individually or as a group) have a voice in determining the rules and regulations of the school.*

Connections to larger professional community: *The linkages between members of the PD group and external individuals or organizations concerned with teaching and learning.*

Connections to parents and larger community: *The linkages between members of the PD group and the parents of their students and local community members and organizations.*

Shared technical language: *Using words or phrases that have a specific meaning to the members of the PD group. This includes instances where participants are negotiating or learning this language.*

Shared history and social cohesion: *Prior events in which some of the PD group members were involved, particularly those events that acted to bond these members together in some way. This includes indicators that participants have had common experiences that have brought them together*.

Roles and relationships within the community: *Indicators of how group members interact with one another in terms of their relative position within the group.* (There is ***no ABCON*** version of this code).

Dynamics of communication: *Patterns of dialogue or written correspondence among PD group members or between these members and other interested individuals.*

Enabling: *Resource(s) used in support of intended science reform (e.g., classroom implementation of immersion or FOSS units, or PD for inquiry/immersion/FOSS teaching and learning.)* ***Note: Enabling is the <u>default code</u> for resources. Append "ABCON" (see below) to a resource code to denote that the resource is largely absent, or, though present, the resource is being used in a way that constrains rather than enables the intended science reform.***

ABCON: *Added to a resource code to indicate the coders' judgment that the resource is: (1) absent, but would likely be enabling if present, or (2) present, but being used in a way that constrains rather than enables the intended science reform. (Note: ABCON may be used in combination with all resource codes except* ***Uncertainty****,* and ***Roles and Relationships within the Community****.)*

Barrier: *Barrier or challenge to implementation of intended science reform, or teaching and learning in general. This code is to be used only to denote instances where interviewee states or strongly implies the factor constitutes a barrier, and only in combination with other non-resource codes.*

Effect: *Effects attributed to a policy, practice, actor, etc. Code to be used only to denote attribution of effect (or non-effect) by interviewee, not coder. Coders' judgments about effects are expressed in codes for "****Enabling,****" and "****ABCON.****"*

Positive: *Attribution of a positive effect of some policy, practice, or actor.*

Negative: *Attribution of a negative effect of some policy, practice, or actor.*

Evidence: *Evidence adduced or implied by interviewee in support of assertion of effects.*