WCER Working Paper No. 2012-2
February 2012

Inquiry-based Science and the *Science Immersion* Instructional Reform in LAUSD

Kimberle A. Kelly
Wisconsin Center for Education Research, University of Wisconsin-Madison
Los Angeles Unified School District

Alexan Chalaganyan
Los Angeles Unified School District

Erika Hernandez
Los Angeles Unified School District

WCER working papers are available on the Internet at http://www.wcer.wisc.edu/publications/workingPapers/index.php. Recommended citation:

> Kelly, K. A., Chalaganyan, A., Hernandez, E. (2012). *Inquiry-based Science and the Science Immersion Instructional Reform in LAUSD.* (WCER Working Paper No. 2012-2). Retrieved from University of Wisconsin–Madison, Wisconsin Center for Education Research website: http://www.wcer.wisc.edu/publications/workingPapers/papers.php

The material in this research brief was generated by a skilled team of research assistants, graduate students, research associates, and senior faculty researchers, who collaborated on an experimental study of *Science Immersion's* effect on teacher instructional practice and student achievement. This project, conducted in the Los Angeles Unified School District, was entitled *System-wide Change: An Experimental Study of Teacher Development and Student Achievement in Elementary Science*, and was supported by a Teacher Professional Continuum (TPC) Grant from the National Science Foundation (NSF) awarded to the University of Wisconsin–Madison (Grant no. 0554566). Science Immersion was part of a larger NSF-funded Mathematics Science Partnership, *System wide Change for All Learners and Educators (SCALE)*, awarded to the University of Wisconsin–Madison. Funding from SCALE supported the design of curricula and intensive professional development to introduce curricula to teachers. An additional grant provided support for the professional development of facilitators and teachers, entitled Quality Educator Development (QED), a Teacher Quality Enhancement Partnership funded by the US Department of Education through California State University, Dominguez Hills. All of these efforts were made possible through partnership with dozens of administrators, hundreds of teachers, and thousands of students in the Los Angeles Unified School District. To all of you, we extend our sincere gratitude. Any opinions, findings, or conclusions expressed in this paper are those of the authors and do not necessarily reflect the views of the funding agencies, WCER, or cooperating institutions. For more information, please contact the authors at akimkelly@gmail.com.

Inquiry-Based Science Instruction and the *Science Immersion* Instructional Reform

The Los Angeles Unified School District (LAUSD) engaged in an elementary science instructional reform in grades 4 and 5 from 2004 to 2009. An experimental study was conducted from 2006 to 2009 in a sample of 80 treatment (40) and comparison (40) schools to assess the reform's effects on student achievement.

This research brief synthesizes the findings of over 25 conference presentations, reports, and publications during the *Science Immersion* reform. We summarize the reform as intended as well as detail findings for each of five implementation steps (Design, Recruit, Deliver, Translate, Reflect). We include comparisons to the simultaneously implemented Full Option Science System (FOSS) curriculum, part of a statewide K-8 science instructional materials adoption. The *Science Immersion* instructional reform supported teachers in implementing extended, inquiry-based curriculum units in their classrooms. Teachers were introduced to the inquiry-based curricula during professional development. Ideally, collaboration in grade-level teams provided further opportunities for teachers to reflect on and improve their instructional practice over time.

Our findings are based on comprehensive samples of self-report, observation, demographic, participation, and performance data. Seldom do studies utilize such a wealth of qualitative and quantitative information about the implementation and outcomes of an instructional reform, and we took full advantage of the available data in honing our conclusions.

The Bottom Line: The critical question for researchers and practitioners is the effect of the *Science Immersion* reform on student performance. We examined scores on standards-based science assessments in treatment and comparison schools, including district Periodic Assessments in Science in grades 4 and 5 and the grade 5 California Standards Test (CST) in Science. Figure 1 illustrates comparable increases in CST scores over the years in LAUSD and the state overall. Despite the fact that treatment and control schools were comparable at the beginning of the study, treatment schools scored significantly lower than control schools at the end of year 1. The effect was more pronounced in the classrooms of Science Lead Teachers (details on p. 6) and in the classrooms of teachers with more years of experience. By the end of year 2, however, there were no longer differences in student achievement between treatment and control schools. We examined the implementation of the *Science Immersion* reform to interpret these findings:

- *Science Immersion* and FOSS curricula both engaged students in inquiry-based learning of grade-level science content standards as written.
- High rates of participation in training and classroom implementation of *Science Immersion* in year 1 were diminished by wider adoption of FOSS in years 2-3.
- Similar patterns of inquiry-based teaching were observed in both professional development and classroom settings, including a consistent lack of attention to students' development and communication of conceptual understanding.
- Available resources were poorly utilized to support teacher reflective practices in peer communities.
- The district context engaged in and supported the reform in year 1, but limited its sustainability after.

We interpret the drop in student achievement in year 1 in the treatment schools as an implementation dip, since most teachers were using the immersion unit for the first time with relatively little ongoing support. The unit placed considerable cognitive demands on both teachers and students. We interpret the finding of no differences in years 2 and 3 to reflect the systemwide abandonment of *Science Immersion* in favor of the FOSS instructional materials adoption. Implications of these findings are discussed for key role groups: 1) teachers in classrooms, 2) school- and district-level instructional leaders, and 3) K-12 researchers who partner with school districts.

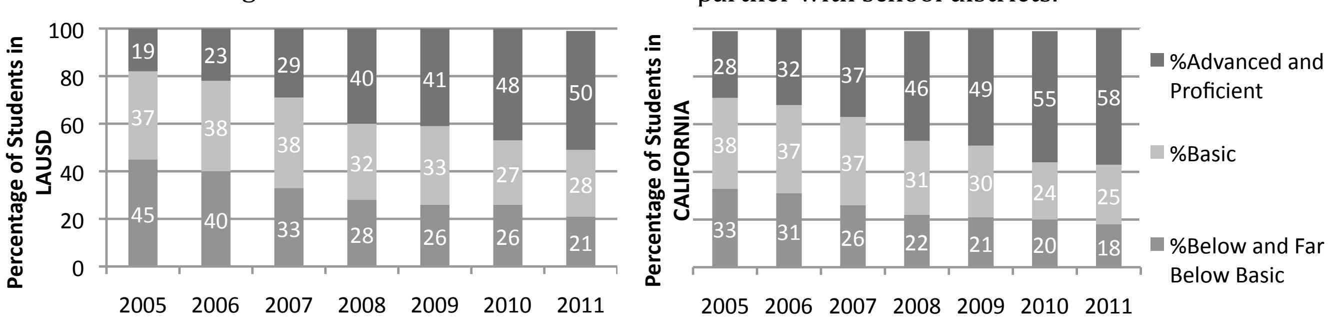

Figure 1: **Annual LAUSD Grade 5 performance levels on the California Standards Test (CST) in Science.** Across the 7 years the Grade 5 CST has been implemented in science, the percentage of proficient and advanced students has increased steadily from 19% to 50% (statewide from 28% to 58%), while the percentage of those scoring below or far below basic has dropped from 45% to 21% (statewide 33% to 18%). From http://star.cde.ca.gov/.

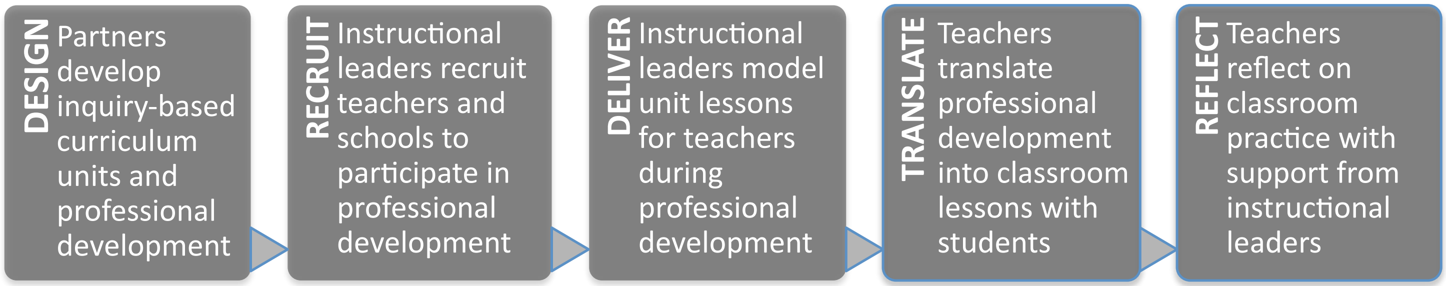

Figure 2: **Implementation steps for the Science Immersion instructional reform and the simultaneous Full Options Science System instructional materials adoption.** The goal of both instructional programs is to improve student achievement on standards-based assessments in elementary science.

Organization of This Brief

The *Science Immersion* reform in grades 4 and 5 is described as a series of implementation steps, all directed at one primary goal: to improve student achievement on standardized elementary science assessments (Figure 2). For each step, we describe the reform as it was intended, along with findings that describe effects on the district as a whole as well as effects on sampled schools, teachers, and students.

Framing the District Context

As teachers must determine what students bring to the table regarding their conceptual understanding of science standards, so researchers must understand what commitment the district brings to the reform. Local context is an important determinant of program implementation because district actors must enable the deployment of available material, human, and social resources to support reform implementation.

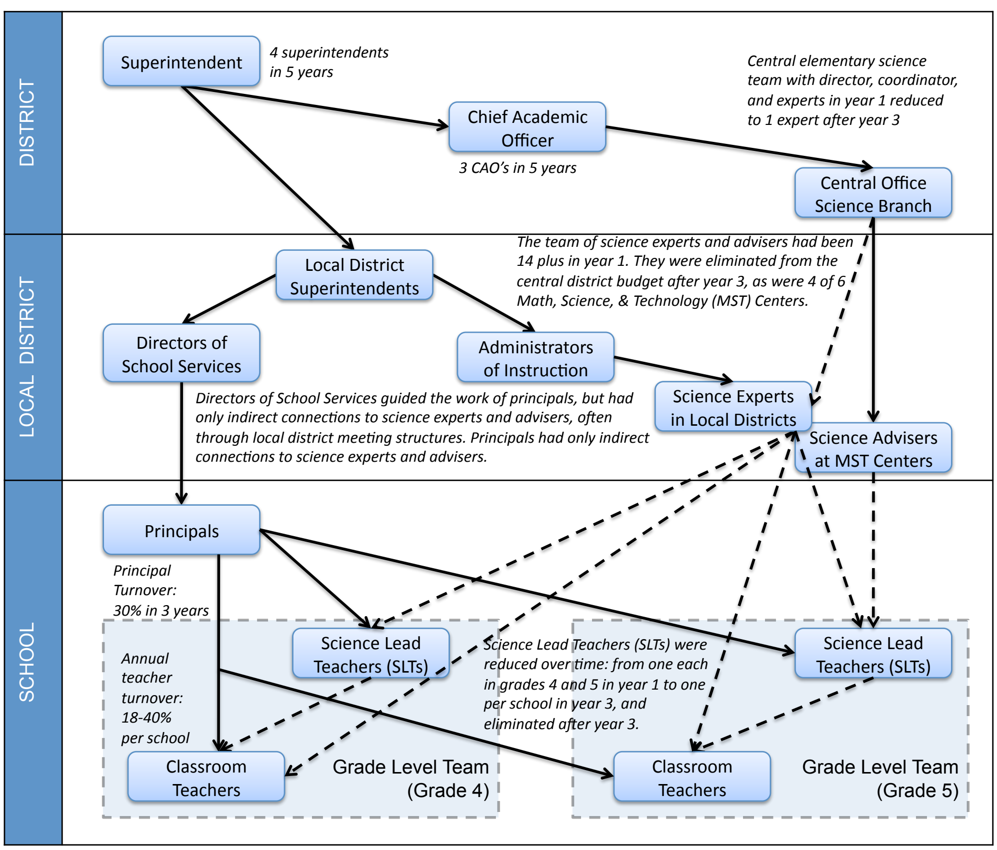

Figure 3: **This organizational chart depicts the groups of actors involved in the Science Immersion reform and responsible for LAUSD's instructional priorities in science.** Solid lines represent direct reporting relationships, while dashed lines indicate non-reporting yet significant influences on science instruction. District instabilities and lines of communication that influenced the sustainability of *Science Immersion* are noted next to relevant role groups.

Finding: District Context Initially Supported yet Ultimately Limited Reform Sustainability

District actors, from the superintendent to classroom teachers, supported *Science Immersion* reform in the initial year of the experimental study (see details in Figure 3). This widespread enthusiasm and support, however, eroded to an insufficient level within two years. The following factors contributed to the abandonment of the reform:

- The district implemented FOSS systemwide as the result of a statewide K-8 science instructional materials adoption.
- Science was not a major part of state or federal accountability requirements, and was afforded less attention from district, local district, and school actors.
- Many indirect relationships among school, local district and district actors limited the communication of instructional priorities and decreased coherence across initiatives.
- Instabilities undermined the sustainability of all district initiatives. An unprecedented budget crisis drastically diminished district science instructional supports. Significant turnover at all levels left few in place by the end of the study (just three years later) who knew *Science Immersion.*

DESIGNING the *Science Immersion* and FOSS Curricula

Collaborative teams of university researchers, district science content experts and teacher leaders designed the "immersion units" and associated professional development for elementary teachers beginning in 2004. The district implemented the Full Options Science System (FOSS) curriculum systemwide during year 2 of the experimental study.

Both curricula were aligned to the national science inquiry standards (Figure 4), the state of California science content standards for grades 4 and 5, district instructional guides, and standardized student assessments in science. The grade 4 immersion unit, *Rot It Right*, consists of 13 lessons covering life science standards concerning the transfer of matter and energy through food chains, the components of ecosystems, and the role of microorganisms in ecosystems. The comparable FOSS unit is the *Environments* kit. The grade 5 immersion unit, *Weather Forces and Prediction,* consists of 21 lessons covering earth science standards concerning the role of convection currents, the ocean, and the water cycle in weather patterns and severe weather events. The comparable FOSS unit is the *Water Planet* kit.

RECRUITING Schools to Send Teachers to Professional Development

Since it was not feasible to provide professional development in *Science Immersion* to all grade 4 and 5 teachers, a random selection process was utilized to select one group of 40 schools (5 per local district) to target for two years (treatment), with a second group of 40 schools to be trained in year 3 (control).

Five Essential Features of Scientific Inquiry

Figure 4: **The National Science Education Standards describe five essential features of inquiry for engaging students in science learning.** We examined how these features of inquiry were embedded into the curriculum, professional development, and in classroom lessons.

Schools were asked to send two teachers to week-long summer institutes with follow-up sessions. Other opportunities to learn about *Science Immersion* were available to all teachers, most notably two-day training sessions with 6 hours of follow up for *Rot It Right*.

The training strategy for FOSS was different; training was less intensive, but it reached many more teachers. Most teachers participated in one day of training covering one kit. Science Lead Teachers (details on p. 6), however, were trained on all three FOSS kits in their grade level.

Finding: *Science Immersion* and FOSS Both Engage Students in Inquiry-based Learning of Grade-Level Science Content Standards

When comparing the FOSS and *Science Immersion* curricula and recruitment strategies, we noted:

- The FOSS curriculum is more highly scripted than *Science Immersion*, with more teacher-guided inquiry (versus student-guided). Teachers reported that FOSS was easier to implement. Prior experience with immersion units may have facilitated FOSS implementation.

- While the immersion units are well aligned to content and inquiry standards, how this applies to individual lessons is not well articulated in the written units. One solution was an implementation wall display utilized during summer institutes to articulate these alignments. This wall display guided fidelity ratings made by researchers across the settings where immersion lessons were implemented.

- While professional development recruitment strategies differed for *Science Immersion* and FOSS, the same district science content experts participated in the design and delivery of both curricula, promoting cross-pollination of best teacher training practices. An example is a blended FOSS and *Science Immersion* curriculum utilized in the 5th grade institutes.

DELIVERING Professional Development to Introduce Inquiry-Based Curricula

Facilitators co-developed the *Science Immersion* Model of Professional Learning (SIMPL, see Lauffer & Lauffer, 2009) along with facilitation guides for the summer institutes in a series of planning meetings. District science content experts engaged in similar design activities during bimonthly meetings to support teachers around *Science Immersion* and FOSS curricula.

The SIMPL model aims to
1) engage teachers in immersion lessons as they are intended to be delivered to students, and
2) engage teachers in reflection around lesson implementation as practitioners.

Thus, training focuses both on what is to be taught to students (content) as well as how to teach it (pedagogy).

TRANSLATING Lessons as Modeled in Professional Development into Classroom Lessons with Students

After training, teachers were to translate what they learned into student lessons delivered at the appropriate time. We observed 196 representative 4th-grade life science lessons in year 1, 236 more in year 2, and 293 5th-grade earth science lessons in year 3.

Both *Science Immersion* and FOSS required disposable supplies for hands-on investigations by students. Prefabricated FOSS kits were provided to every school, although their use had to be coordinated among teachers, and the kits required ongoing refurbishment. Immersion units required teachers to seek supplies through district Mathematics, Science, and Technology centers or obtain them on their own.

Finding: High Rates of Participation and Classroom Implementation of *Science Immersion* Were Diminished by Wider Adoption of FOSS

- More teachers from treatment schools (48) attended summer immersion institutes in year 1 than did in years 2 and 3 combined (47), when FOSS training was the district priority.
- While nearly 60% of observed lessons utilized the immersion unit in year 1, this dropped to 25% in year 2 with the introduction of FOSS.
- While nearly 18% of science content expert meeting time was devoted to *Science Immersion* in year 1, by year 2 it was barely mentioned, with FOSS topics dominating the agenda instead.

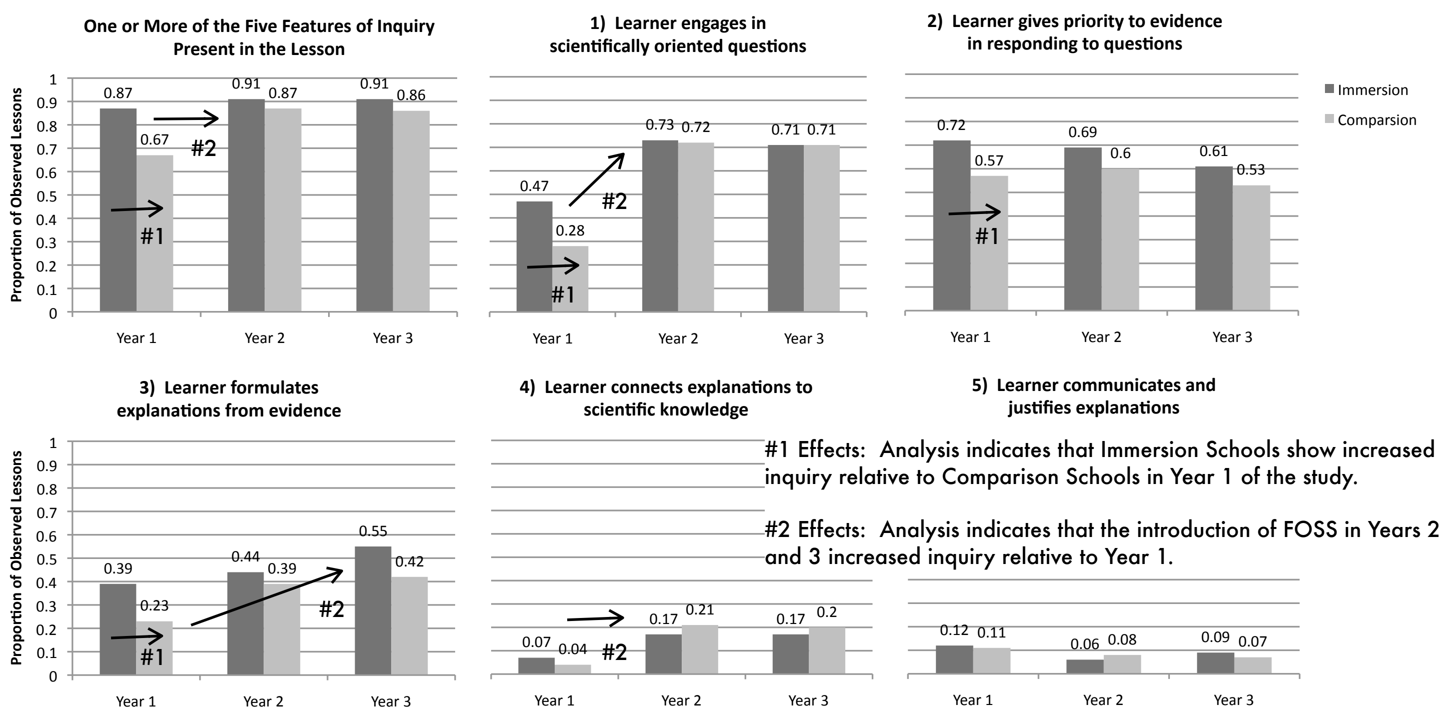

Figure 5: **Proportion of observed lessons containing the essential features of inquiry for each year of classroom observations.** We verified that each feature of inquiry received significant emphasis in the written immersion units. While all features of inquiry were observed in classroom lessons, features 4 and 5 were observed less than would be expected if the immersion unit were implemented as written. Two kinds of effects were statistically analyzed: *#1 Effects:* Differences between treatment and control schools to measure the effects of *Science Immersion* on the amount of inquiry in classroom lessons, and *#2 Effects*: Differences between the first year of the study (pre-FOSS) and years 2 and 3 (FOSS rolled out districtwide to all schools) to measure effects of FOSS on the amount of inquiry in classroom lessons. Significant differences for each feature of inquiry are indicated in the bar graphs above.

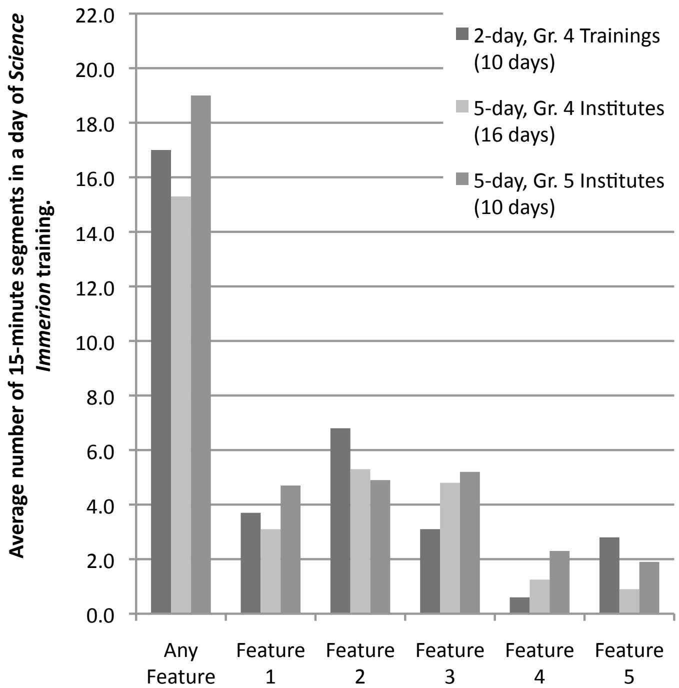

Figure 6: **Number of training segments containing features of inquiry in Science Immersion professional development.** Like classrooms, while professional development sessions in *Science Immersion* engaged teachers in all five essential features of inquiry, Features 4 and 5 were observed less often than would be expected from the written immersion units. Further, there was considerable variation in the relative emphasis of content and pedagogy across institutes, even at the same grade level during the same year.

Finding: Similar Patterns of Inquiry-Based Teaching Were Observed in Professional Development and Classrooms

As implied by the SIMPL, both professional development and classroom settings should exhibit patterns of inquiry features that mirror immersion unit lessons.

- A high proportion of lessons contained features of inquiry across all years of the study (Figure 5, top left panel). Analysis confirmed that both *Science Immersion* (in year 1) and FOSS (in years 2 and 3) were associated with an increase in inquiry teaching. Figure 5 summarizes significant effects of *Science Immersion* and FOSS on the five essential features of inquiry in classrooms.

- The proportion of lessons with inquiry features 4 and 5 was lower than expected. These features reflect connecting evidence-based explanations to the current body of scientific knowledge and articulating that understanding, critical for consolidating learning from investigation-based experiences.

- Similar distributions of inquiry features were observed in immersion professional development settings (Figure 6). The consistency of lesson delivery during training was better in the early half of the immersion unit. Not only were later lessons delivered less consistently during training, they were also observed less frequently in classrooms, despite efforts to obtain observations of all unit lessons.

- The challenges of teaching scientific inquiry included time pressures on instruction and a lack of ongoing attention to practice or reflection. Given the intellectual demands of scientific inquiry on teachers and students, it is understandable that student achievement dropped in year 1 in the treatment schools, reflecting an implementation dip. Most teachers were using the immersion unit for the first time with little ongoing support.

REFLECTING on Practice and Performance with Peers

Translation and reflection are critical components of teachers' instructional practice. Without support for reflection about practice and achievement data in peer communities, teachers are less likely to reach desired lesson implementation levels.

To support science instruction on site, each school designated Science Lead Teachers (SLTs) in grades 4 and 5 from 2004-2009. SLTs were a specific target for most elementary science professional development. They also coordinated grade level meetings to support teacher reflection around classroom practice and assessment data.

Finding: Supports for Reflective Practice with Peers were Poorly Utilized

While supports for teachers implementing immersion were made available, they were not well utilized. Examples include:

- Follow-up sessions engaged teachers in reflection around implementation and student work, but were poorly attended.

- While SLTs were initially targeted for immersion training so they could share the units with other teachers, they were not specifically trained or charged to do so. Many SLTs were not prepared to facilitate effective grade level meetings.

- Grade-level meetings occurred at most schools, but logistical issues dominated content (e.g., coordinating FOSS kits across classrooms). While some schools reported a supportive professional climate and shared commitments around immersion in year 1, this was no longer evident by year 3.

Implications of the Findings for Future Efforts: What Can You Do?

What can teachers, district leaders, and educational researchers learn from this study of science instructional reform? Here, we explore the implications of our findings for future efforts in LAUSD and beyond.

For Elementary Teachers

While many teachers reported having difficulty completing the immersion units in a timely manner, they were positive about trying again because their students liked them. The inherent appeal of authentic science investigations invites student engagement, a prerequisite to effective teaching.

The implementation difficulties of inquiry-based curricula are both intellectual (cognitively challenging) and logistical (need for and coordination of materials). These challenges should be anticipated. They are also necessary—there is no shortcut to improving instruction—time and effort are necessary to develop inquiry-based instructional practice. Students must also invest time and effort in their learning.

Getting initial professional development is insufficient for high quality implementation. Instructional collaborations with grade-level colleagues and content experts leverage the collective expertise of the group to support students. Teachers should not pass up available opportunities to practice and reflect on lessons.

A more explicit focus on the relationship between teaching practices and student learning should guide instruction. If teachers can better recognize features of inquiry and the cognitive demands placed on students in their instruction, they can better facilitate students' development and articulation of conceptual understanding in science.

For District Instructional Leaders, Curriculum Developers and Trainers

Science Immersion was fully incorporated into district efforts in science through administrative and support structures already in place. FOSS exemplified the systemwide launch of a curriculum, resulting in an immediate shift across all levels of LAUSD to the FOSS curriculum. Both curricula illustrate the feasibility of systemwide change.

Instructionally, however, both *Science Immersion* and FOSS lessons consistently spent little time on the development and articulation of conceptual understanding in science. While a supportive context can launch systemwide reform initiatives, sustained resources and high quality practices are needed to transform teaching and learning.

Specific solutions regarding curriculum design and delivery include the explicit alignment of lessons to standards and features of inquiry. The demands of implementation on teachers should guide the selection of training strategies (such as scripted teachers' guides, the SIMPL facilitation model) as well as decisions about who to train and how much training to offer.

In planning initiatives, the district should calculate the resources required for program implementation given current and projected staffing, turnover, and budget profiles. Estimates should include ongoing material demands for instruction and the logistics of their distribution. Reform activities must be appropriate given available instructional time and resources.

The success and sustainability of a reform effort is directly related to the ongoing time and effort of decision-making role groups. Creating structures and supports for ongoing reform activities must be a priority. Collaborations among instructional leaders, trainers, and teachers should be held regularly, and focused on reflective and mentoring practices. It takes effort and practice to get inquiry right; this applies equally to teachers, trainers, and administrators who guide instructional policies.

For Researchers Interested in District Partnerships

In addition to knowing the issues relevant to teachers and district leaders, researchers must anticipate national, state, and district policy contexts and their potential impact on reform implementation. While researchers attempted to account for the changing district context during *Science Immersion*, the FOSS adoption, unknown to researchers in advance, simply swept immersion away.

Authentic partnership involves regular and consistent collaboration among all role groups at all phases of reform implementation. When all role groups find value and are valued in collaborations, commitment and quality of effort increases.

We made an effort to share our findings along the way with teachers, district leaders, and content experts. Consistent efforts to make meaning and thus inform decision-making are ideally part of the reflective practices of all those who support teachers in their classrooms. Results from this study have also been shared regularly at conferences, and are starting to be published.

to learn more

PUBLICATIONS AND PRESENTATIONS OF THE SYSTEMWIDE CHANGE STUDY

Borman, G.D., Gamoran, A., & Bowdon, J. (2008). A randomized trial of teacher development in elementary science: First-year achievement effects. *Journal of Research on Educational Effectiveness, 1,* 237-264.

Borman, G.D., Gamoran, A., & Bowdon, J. (2010, May). *The final outcomes of a school-randomized trial on the effects of professional development on student achievement in elementary science.* Paper presented at the annual meeting of the American Educational Research Association, Denver, CO.

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

Bowdon, J., & Cowan, J. (2011, April). The effects of professional development exposure on Science achievement: Using an instrumental variable approach with multi-year and multi-level data. Paper presented at the 2011 American Educational Research Association Annual Meeting, New Orleans, LA.

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

Condon, M.R. & Schrager, S.M. (2008, March). *When theory and practice meet: Lessons from an urban district school-randomized trial.* Paper presented at the annual meeting of the American Educational Research Association, New York, NY.

Gamoran, A., Borman, G.D., & Bowdon, J. (2011, October). *Challenges of scaling up and sustaining reform: Lessons from a mixed-methods study of professional development for elementary science*. Presented at the Society for Research on Educational Effectiveness, Washington DC.

Gamoran, A., Grigg, J., Hanselman, P.C., & Collares, A.C. (2008, March). *Teacher participation in professional development: The case of first year implementation of science reform in Los Angeles.* Paper presented at the annual meeting of the American Educational Research Association, New York.

Grigg, J., Kelly, K.A., Gamoran, A., & Borman, G.D. (manuscript submitted for publication). *Effects of two inquiry Science professional development interventions on classroom instruction.*

Hanselman, P., Grigg, J., & Bruch, S (2010, May). *Treatment effect heterogeneity in a Science professional development initiative: The role of school capacity.* Paper presented at the annual meeting of the American Educational Research Association, Denver, CO.

Kelly, K.A., Schrager, S.M., & Condon, M.R. (2011, April). *Tracing the implementation of inquiry-based instructional practice in elementary science across practice settings*. Paper presented at the 2011 American Educational Research Association Annual Meeting, New Orleans, LA.

Lal, S. & Osisioma, I. (2010, May). *Classroom perspectives: Observation of the implementation of a fourth grade immersion science inquiry curriculum*. Paper presented at the annual meeting of the American Educational Research Association, Denver, CO.

Lauffer, H.B., & Lauffer, D. (2009). Building professional development cadres. In S. Mundry and K. Stiles (Eds.), *Professional learning communities for Science teaching: Lessons from research and practice* (pp. 55-72). Arlington, VA: National Science Teachers Association.

Osthoff, E.J., Shewakramani, V., & Kelly, K. (2010). System-wide reform in science: The *impact of district and school context–Part I* (WCER Working Paper No. 2010-4). Retrieved from University of Wisconsin–Madison, Wisconsin Center for Education Research website: http://www.wcer.wisc.edu/publications/workingPapers/papers.php

Osthoff, E.J., Shewakramani, V., & Kelly, K. (2010, May). *School perspectives on the effects of organizational resources on implementation of inquiry science instructional reform.* Paper presented at the annual meeting of the American Educational Research Association, Denver, CO.