OBSERVING FOR EVIDENCE OF LEARNING

A School-Based Professional Development Model for Science and Mathematics Teaching and Learning

Overview

GUIDING QUESTIONS

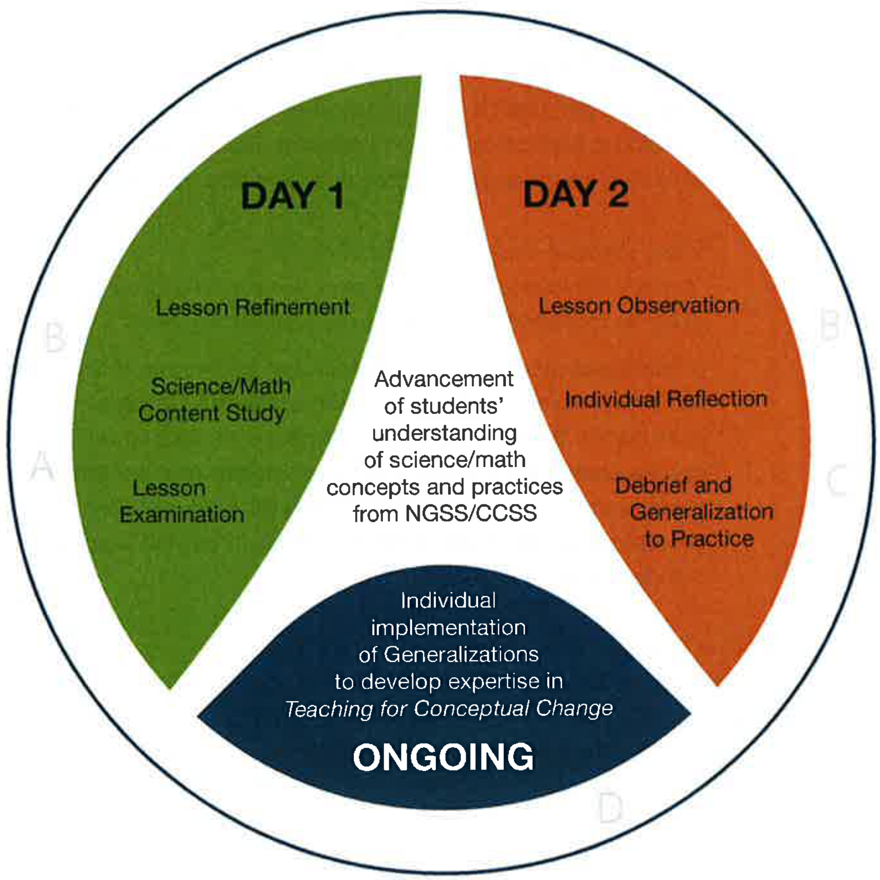
A. From our PLC team's prior experience, what do our students understand about the key concepts from this block of lessons?

B. In our PLC team's lesson study, what specific evidence do we collect to show us that learning occurred?

C. What are our PLC team's proven practices that raised cognitive demand on all students and led them towards conceptual understanding ?

D. In my classroom, how will I achieve a high level of use of this deep learning approach for CCSS / NGSS key concepts and practices?

OEL CYCLE



ISB Logan Center for Education

OEL Research Base

The OEL theory of action describes a vision of high-quality teaching and learning that affords OEL participants a clear purpose for their involvement in OEL professional development. The OEL professional development model is based on science and math education research and cognitive research.

Student Learning:

The OEL professional development model enables teachers to effectively implement learning theory into their classrooms, resulting in the advancement of students' understanding of core concepts. The OEL cycle guides teachers to examine the 3 key findings from the research synthesis detailed in the book How People Learn (Bransford, 2000; Donovan, Bransford, & Pellegrino, 2007) in the context of the research-based instructional materials (e.g., BSCS, IAT, SEPUP, STC, FOSS, etc.) for a specific lesson.

How People Learn Key Finding 1

"Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom."

In the classroom, addressing preconceptions occurs at the start of a new unit of study. OEL cycles allow teachers to identify effective strategies for addressing preconceptions that can be generalized to other lessons.

How People Learn Key Finding 2

"To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application."

Teachers can use OEL to incorporate instructional strategies that guide students to build on earlier learning and develop a sophisticated and enduring understanding of concepts. Teachers learn to establish a foundation of factual knowledge and provide numerous examples of the same concept.

How People Learn Key Finding 3

"A metacognitive approach to instruction can help students learn to control their own learning by defining learning goals and monitoring their progress in achieving them."

In the assessment-centered classroom environment, formative assessments help both the teacher and students monitor progress. OEL helps teachers learn to integrate formative assessment into lessons to reveal changes in students' thinking about challenging concepts to both the teacher and the students. Formative assessment results enable teachers to identify students' preconceptions, understand where students are in the development process from informal to formal thinking, and design instruction accordingly. Formative assessment results prompt students to reflect on how their understanding has changed and the conditions that best promote their own learning.

Teacher Professional Growth:

All science/math teachers in a school are released from their classroom teaching responsibilities to participate in each 2 day OEL cycle together. The OEL cycle comprises 7 phases that each entail a specific set of tasks guided by the OEL facilitator. The first 4 phases (Lesson Examination, Content Study, Lesson Refinement, and Classroom Observation) are based in part on the Lesson Study model (Lewis, 2002; Lewis, 2006; Lewis, Perry, & Murata, 2006). The next phases (Individual Reflection and Debrief and Generalization to Practice) are based on tenets of professional learning communities (DuFour, 2004; DuFour, DuFour, Eaker, & Many 2006; Vescio, Ross, & Adams, 2008), and the final, ongoing phase (Individual Implementation of Generalizations) is based on research on teacher professional growth (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2010).

The purpose of the OEL professional development model is to enact learning theory in all science or math classrooms.

OEL Instructional Vision

IF

Science teachers apply the **How People Learn** findings,

and use **effective instructional materials and teaching practices to:**

- elicit students' initial ideas
- engage students intellectually with important science content
- provide opportunities for students to confront their ideas with evidence
- help students formulate new ideas based on that evidence
- encourage students to reflect upon how their ideas have evolved

and ensure students can do the **NGSS Science and Engineering Practices:**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

THEN

Students' understanding of the **Next Generation Science Standards** will be deeper and their science achievement will increase.

IF

Math teachers apply the **How People Learn** findings,

and use the **effective mathematics teaching practices to:**

- establish mathematical goals to focus learning
- implement tasks that promote reasoning and problem solving
- use and connect mathematical representations
- facilitate meaningful mathematical discourse
- pose purposeful questions
- build procedural fluency from conceptual understanding
- support productive struggle in learning mathematics
- elicit and use evidence of student thinking

and ensure students can do the **Common Core State Standards for Mathematical Practice:**

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

THEN

Students' understanding of the **Common Core State Standards for Mathematical Content** will be deeper and their math achievement will increase.

OEL Cycle Phases

The OEL professional development model provides the structure for a rigorous learning cycle for teachers using common, standards-based core instructional materials. The 2-day cycle is repeated 3–4 times per academic year.

DAY ONE

Lesson Examination

Teachers

- Select a lesson that addresses a core science or math concept their students have demonstrated difficulty understanding.
- Review the lesson design by following the lessons as a student.
- Examine past evidence of students' misconceptions and difficulties understanding the concept.

Content Study

Teachers

- Consult with the OEL content expert, or an expert in the content area.
- Work on improving teachers' own content and pedagogical content knowledge.
- Develop statements that clearly identify the big ideas that students will learn.

Lesson Refinement

Teachers

- Refine the lesson plan by integrating the instructional strategies that support student learning of the core science or math concept (e.g., craft questions that advance student thinking to higher levels of cognitive demand, diversify the lesson for all learners).

DAY TWO

Lesson Observation

The demonstration teacher

- Executes the collaboratively revised lesson as planned by the team.

The teacher observers

- Use the Observation Rubric to prepare for and conduct the observation.
- Collect evidence of student learning.

Individual Reflection

Teachers

- Reflect on their observations of student learning in terms of *What happened? How did it play out? Why did learning occur in the observed way?*

Debrief and Generalization to Practice

Teachers

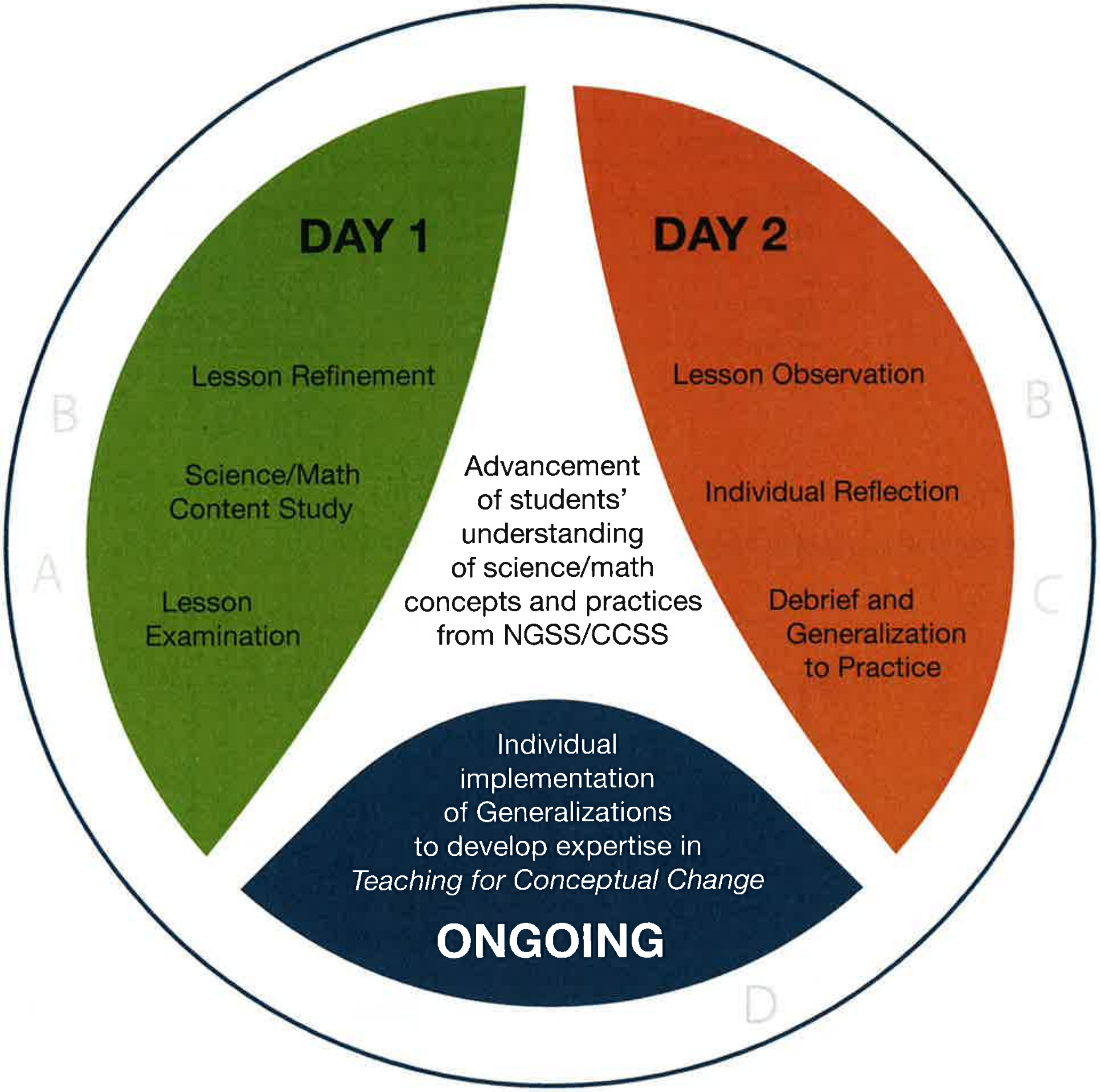
- Focus discussion on the observed evidence of student learning of the core science or math concept.
- Make connections between instructional strategies used in the lesson and student learning.
- Make generalizations about how effective strategies can be applied to other lessons.

ONGOING

Individual Implementation of Generalizations to Develop Expertise in Teaching for Conceptual Change

Teachers

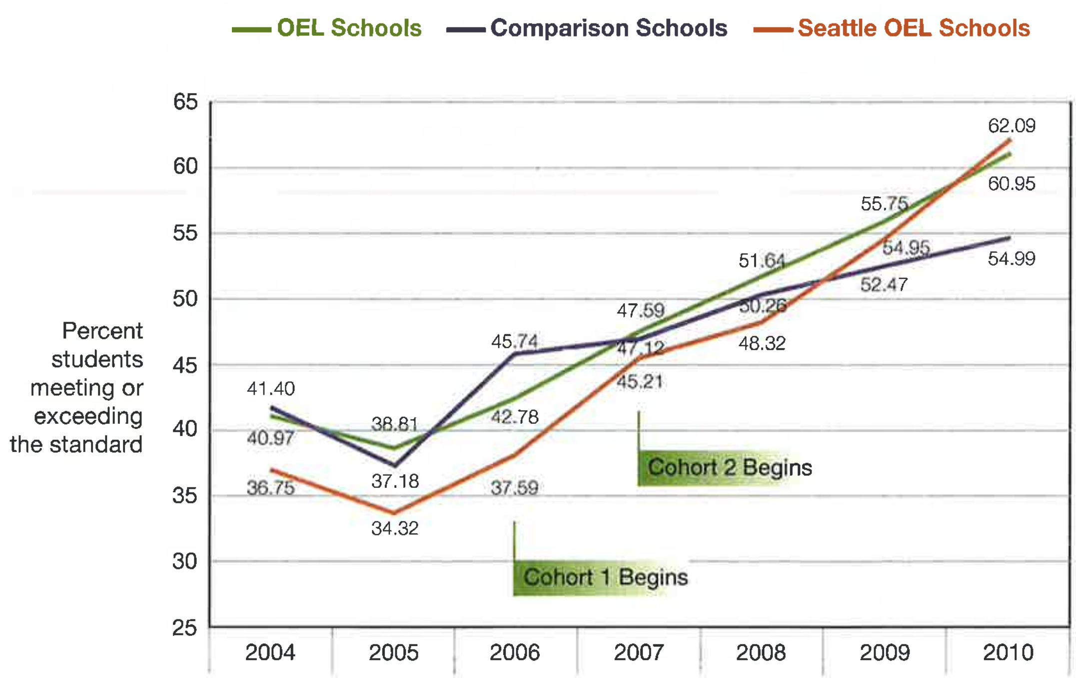
- Enact their team's generalizations to practice in their own classroom.
- Collect and analyze student work to inform their own teaching.
- Share lessons learned from implementing generalizations to practice with colleagues.


DAY 1
Lesson Refinement
Science/Math Content Study
Lesson Examination
DAY 2
Lesson Observation
Individual Reflection
Debrief and Generalization to Practice
Advancement of students' understanding of science/math concepts and practices from NGSS/CCSS
Individual implementation of Generalizations to develop expertise in *Teaching for Conceptual Change*
ONGOING
A
B
B
C
D

Demographic Comparison of OEL and Comparison Schools

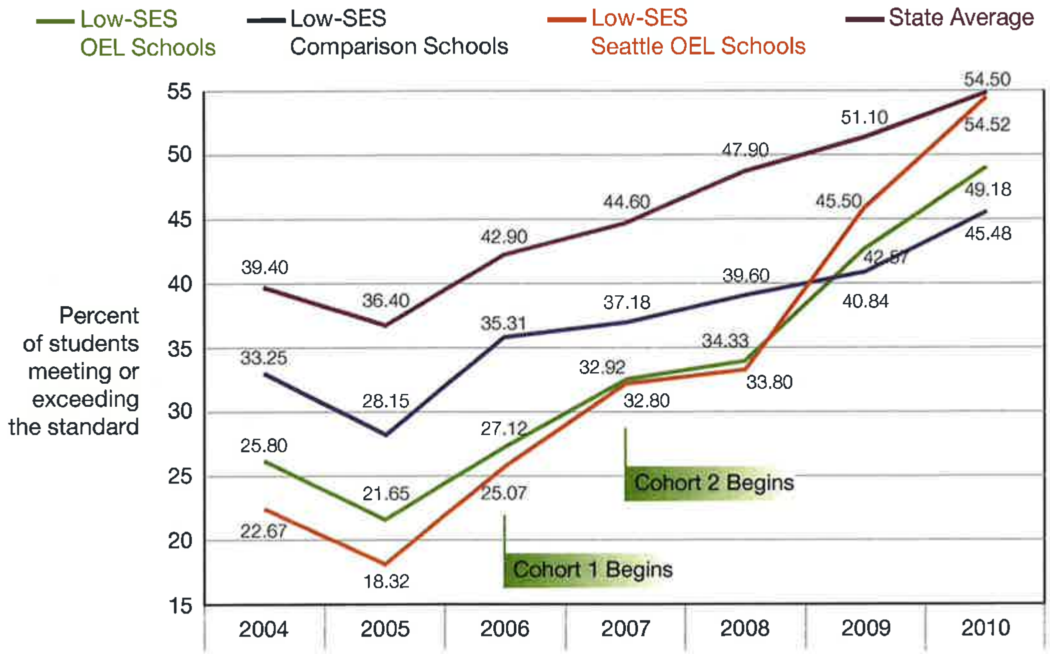
Category	OEL Schools	Comparison Schools
N	21	21
Enrollment	15.268	14.315
Asian	24.30%	17.10%
Native American	1.50%	1.70%
Black	13.20%	12.60%
Hispanic	13.70%	11.50%
ELL	7.90%	4.90%
FRL	36.20%	37.20%

OEL Schools Compared to a Matched Set of Nonparticipating Schools



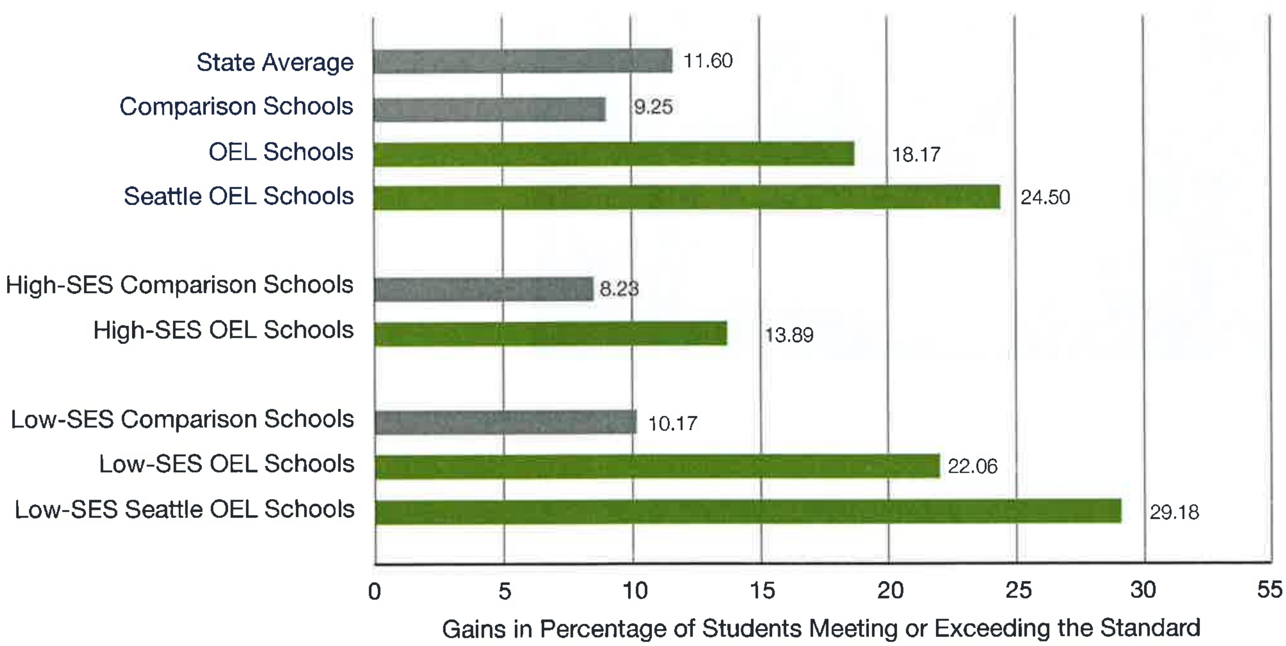
Note: OEL Schools n=21, Comparison Schools n=21, Seattle OEL Schools n=11. In 2010, the difference between OEL Schools and the Comparison Schools was statistically significant at $p<0.05$.

Comparison of Low Socioeconomic Schools



Note: Low-SES OEL Schools n=11, Comparison Low-SES Schools n=11, Seattle Low-SES OEL Schools n=6. Low-SES schools served a student population with a free and reduced priced meas rate equal to or higher than 40%.

Gains in Student Achievement 2006 to 2010



Note: Green bars denote the gains in OEL Schools and grey bars denote gains in the matched Comparison Schools or the state average.

Analysis by Socioeconomics

To analyze the results with respect to socioeconomics, RMC Research used the percentage of students who qualified for free or reduced price lunch (FRL) as a proxy for the socioeconomic status (SES) of the community served by each OEL school. To explore this relationship, RMC Research divided the OEL schools into 2 groups according to the average percentage of students who qualified for FRL between 2004 and 2010. If less than 40% of students qualified for FRL the school was designated a high SES school and if more than 40% of students qualified for FRL the school was classified as low SES. The graph to the right displays the results of the comparison of the high SES OEL schools and the high SES comparison schools. Although the gap widened somewhat between the 2 groups over the project period the difference was not significant for any year.

The first graph to the right illustrates the comparison of the low SES schools and the subset of low SES OEL schools in Seattle. Prior to the project, Grade 8 students in the low SES OEL schools scored well below their counterparts in the comparison schools and both groups scored well below the state average. At the beginning of the OEL project, the participating schools began to close the gap. By 2009 Grade 8 students in OEL schools outperformed their comparison school counterparts and the gap continued to widen in 2010. The gains were the most pronounced among students in the Seattle schools. Students in the low SES Seattle schools surpassed their counterparts in the comparison schools and achieved at a level that matched the state average.

The horizontal bar chart to the right shows the change in the percentage of students who met the Grade 8 science assessment standard between 2006 and the conclusion of the project in 2010. In every case schools involved in the OEL project showed greater gains in Grade 8 student science achievement than the students in their matched comparison school and relative to the state average. Low socioeconomic schools showed greater gains than the high socioeconomic schools, comparison schools, and the state average. Low socioeconomic schools in Seattle increased the percentage of students who met the Grade 8 science standard by nearly 3 times that of the comparison schools and the state average over the 4 year project period.

Attribution

These results are very encouraging, however, the critical reader will want to know the degree to which these findings can be attributed to the OEL model or whether the results stem from some other influence within the participating schools. In this case, OEL was a very large factor that led to the increase in student achievement because of the following characteristics of the research methods.

- The OEL model is very well defined in terms of both the process and the purpose for the professional development. As a result, fidelity of implementation of the OEL model could be consistently determined and monitored. The high level of fidelity of OEL implementation indicates that the positive results were not the result of ad-hoc adaptations made by school staff during implementation.
- OEL was the only major professional development effort that directly impacted science teachers that was consistently implemented during the project period.
- The comparison schools very closely matched the OEL schools with respect to student demographics, school size, grades served, special populations such as English language learners, socioeconomics of the local community as measured by the percentage of students who qualified for free or reduced price lunch, and the type of community served by the school (urban, suburban, or rural). As a result, it was not necessary to use any statistical methods to adjust for uncontrolled differences.
- The multiyear performance of the control schools paralleled that of the state average, whereas the OEL schools increased at a greater rate than both the state average and the comparison schools beginning with the onset of the project.
- Most uncontrolled factors such as variations in the assessment or changes in state standards impacted the OEL schools and the control schools equally.

Threats to Validity

The primary threats to validity stems from factors that were uncontrollable and isolated to specific schools or districts during the implementation of the project. For example, one school district experienced a strike and a major curriculum change during the project that proved to be a significant distraction for participating teachers. Another district conducted a mathematics improvement initiative at the same time as the OEL project. This made it very difficult for the science staff to schedule OEL sessions because of a lack of substitute teachers. Other districts experimented with alternative schedules for conducting OEL sessions. Many of these activities are not particularly unusual among schools and districts. As a result, it is safe to assume that similar things occurred in at least some of the comparison schools. The degree to which such factors influenced the results cannot be determined but if anything, these factors would diminish the impact of the OEL model. Consequently, had these factors not occurred or been mitigated somehow, it is reasonably to conclude that the impact of the project on student achievement would have been even greater.

Could we control all variables?   NO!