



**The LASER Model:**

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**A Systemic and Sustainable Approach for Achieving High Standards in Science Education**

**Regional Highlights:**

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**New Mexico**



**Smithsonian**  
*Science Education Center*

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“The Investing in Innovation Fund, established under section 14007 of the American Recovery and Reinvestment Act of 2009 (ARRA), provides funding to support (1) local educational agencies (LEAs) and (2) nonprofit organizations in partnership with (a) one or more LEAs or (b) a consortium of schools. The purpose of this program is to provide competitive grants to applicants with a record of improving student achievement and attainment in order to expand the implementation of, and investment in, innovative practices that are demonstrated to have an impact on improving student achievement or student growth, closing achievement gaps, decreasing dropout rates, increasing high school graduation rates, or increasing college enrollment and completion rates.

These grants will (1) allow eligible entities to expand and develop innovative practices that can serve as models of best practices, (2) allow eligible entities to work in partnership with the private sector and the philanthropic community, and (3) identify and document best practices that can be shared and taken to scale based on demonstrated success.”

– U.S. Department of Education,  
<http://www2.ed.gov/programs/innovation>



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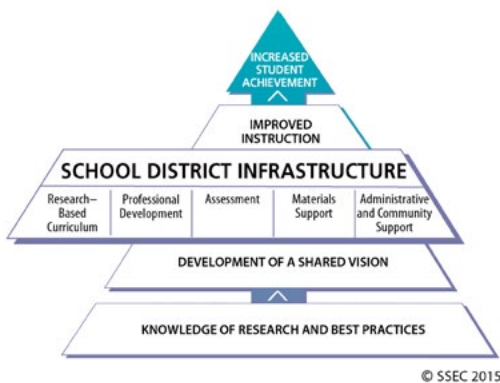
## Regional Highlights

## NC NM HISD



A student in New Mexico examines a larva using a hand lens from the STC™ unit *Life Cycle of Butterflies*.

Fig. 1 SSEC's Theory of Action



The SSEC's Theory of Action describes how research and a shared vision of inquiry science supports the five elements of the LASER model. When all of the elements are addressed together, they support increased student achievement.



### VIDEO 1:

Inquiry science is vital  
<http://bit.ly/science-is-vital>

The results of the LASER i3 validation study are in! What's more, they bring great news about the impact of inquiry science education on student achievement in elementary and middle schools in New Mexico, North Carolina, and the Houston Independent School District (HISD).

### What do we mean by "inquiry"?

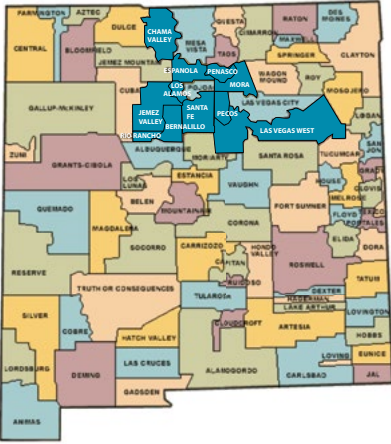
Inquiry-based learning and teaching is rooted in decades of research on how students learn. Inquiry is a student-centered method of teaching in which the instructor facilitates conversation and hands-on investigation rather than reciting facts. Students and teachers in inquiry classrooms work together to design investigations, analyze data, and construct explanations, often while incorporating reading and math skills, as seen in Video 1.

### What is LASER i3?

In 2010 the U.S. Department of Education awarded the Smithsonian Science Education Center (SSEC) a five-year Investing in Innovation (i3) validation grant to evaluate the LASER model's efficacy in systemically transforming science education. The LASER (Leadership and Assistance for Science Education Reform) model, developed by the SSEC, is a systemic approach to transforming science education consisting of five elements: a research-based, inquiry-driven science curriculum; differentiated professional development; administrative and community support; materials support; and assessment. These elements, when planned around a shared vision for science, form the infrastructure to sustain student-centered learning and teaching, as seen in Figure 1. "LASER i3" refers to the longitudinal study of the LASER model conducted by the Center for Research in Educational Policy (CREP) at the University of Memphis.

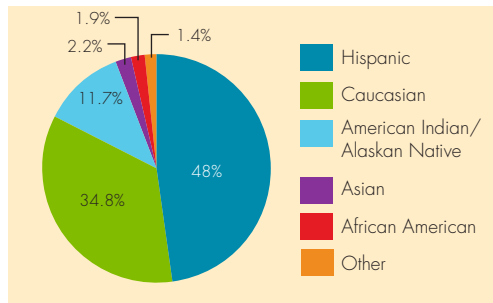
### How did the researchers validate LASER?

Evaluators from CREP studied approximately 60,000 students attending public elementary and middle schools (urban, rural, and suburban), 20.9% of whom were enrolled in eight school districts in northern New Mexico. The others attended 50 schools in the HISD and seven school districts in North Carolina. CREP employed a matched-pair randomized controlled trial (RCT) using a comparison group design<sup>1</sup> to investigate whether students in schools implementing the LASER model during a three-year period outperformed students who were not exposed to LASER during the same time period.<sup>2</sup>



LASER i3 Project included the following New Mexico School Districts: Bernalillo Public Schools, Chama Valley Independent School District, Jemez Valley Public Schools, Los Alamos Public Schools, Mora Independent School District, Pecos Independent School District, Rio Rancho Public Schools, Santa Fe Public Schools, Espanola Municipal Schools, Penasco Independent School District, West Las Vegas Public Schools.

Fig. 2 **LASER i3 Student Demographics – NM Sample**



Sample size (n) is 12,589. Adapted from CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, 2013-14 Annual Report" (Memphis: CREP / University of Memphis, September 2014), 18.

The evaluators began the study with a subsample of more than 9,000 students in elementary and middle school cohorts.<sup>3</sup> CREP assessed the cumulative impact of the SSEC's products and services over three successive school years for selected elementary (grades 3–5) and middle school (grades 6–8) students. Those receiving the intervention were referred to as the "LASER" group and those who did not were the comparison group. CREP reported on student gains from the baseline assessment (Fall 2011) to final post-tests (Spring 2014). In addition to this aggregate data, the evaluators collected detailed information from a subset of focal schools and conducted case studies to better contextualize their data output.

## Why does LASER i3 matter in New Mexico?

The growing diversity of student populations throughout the United States is represented in the demographic makeup of the LASER i3 student sample from New Mexico, which was 48% Hispanic, 34.8% Caucasian, 11.7% American Indian/Alaskan Native, 2.2% Asian, and 1.9% African American as shown in Figure 2. Of these students, 58% qualified as economically disadvantaged, defined by free and reduced price lunch (FRL) participation.<sup>4</sup> The aggregate 12,589 students and 432 teachers who took part in this study spanned 8 school districts and 33 schools ranging in enrollment from 26 to 984 students.<sup>5</sup>

## What were the outcomes of LASER i3?

The LASER i3 study resulted in many statistically significant<sup>6</sup> and educationally meaningful<sup>7</sup> improvements in achievement in science as well as in reading. "Statistical significance" refers to the likelihood that an outcome can be attributed to a specific cause (i.e., improved student achievement due to the LASER model). "Educationally meaningful" signifies the magnitude of difference between two measures (i.e., the LASER and comparison groups) has practical significance. These results

were achieved through analysis of elementary and middle school state standardized assessments. To compare students across all three regions, schools participating in the study also administered the Partnership for the Assessment of Standards-Based Science (PASS)<sup>8</sup>, which consisted of multiple-choice questions, open-ended questions, and hands-on performance tasks. Disaggregated data show that the positive benefits recorded in science, as well as in reading, due to implementation of the LASER model transcended all social, economic, and ethnic boundaries.

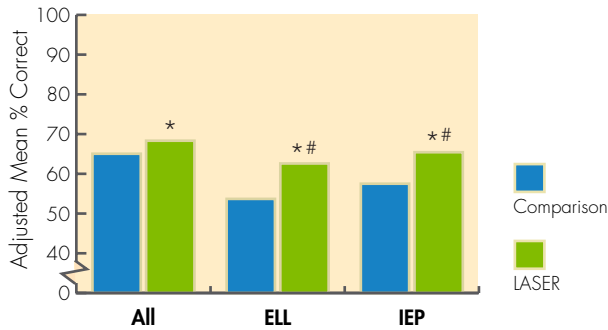
## What does the PASS tell us about New Mexico LASER student outcomes?

The strongest gains in the PASS assessments by LASER students relative to the comparison group were seen in the hands-on performance tasks, followed by the open-ended, and finally, multiple-choice questions.<sup>9</sup> Gains in the PASS performance task scores are particularly noteworthy. These gains indicate students are able to apply what they

have learned in science to hands-on tasks, just as professional scientists apply their expertise to conduct scientific investigations and solve complex problems.

All elementary school students in NM LASER schools showed statistically significant achievement outcomes on the **PASS performance task** relative to the comparison group. The real standouts, however, were English language learners (ELL) and those students with individualized education programs (IEPs) whose results were also educationally meaningful (Figure 3).<sup>10</sup>

Fig. 3 **NM Elementary – PASS Performance Task**

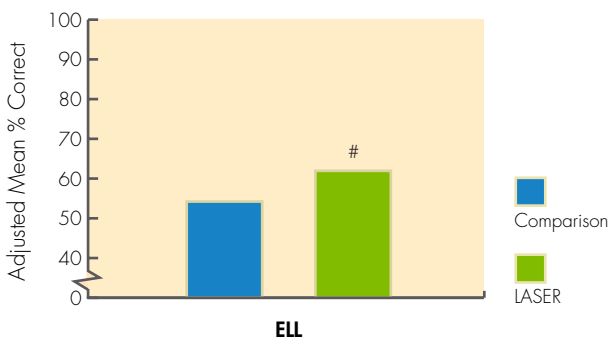


“\*\*” indicates statistically significant results. “#” indicates educationally meaningful results. NM indicates New Mexico. Comparison group sample size (n) is 197 students and LASER sample size (n) is 376 students. ELL students are English Language Learners. ELL comparison (n= 31) and LASER (n=64). IEP students possess individualized education programs. IEP comparison (n=22) and LASER (n=48). Adapted from CREP, “The LASER Model, Summative Report, Section 4” (Memphis: CREP / University of Memphis, July 15, 2015).

The **PASS open-ended assessments** required students to “communicate scientific information, inquire, reason scientifically, and use science to express positions in societal issues.”<sup>11</sup> Once again, elementary ELL students in LASER schools outperformed their counterparts with educationally meaningful gains (Figure 4).<sup>12</sup>

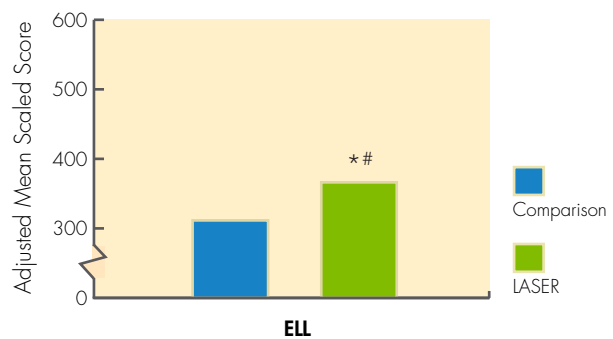
The **PASS multiple-choice questions** assess student “understanding of important scientific facts, concepts, principles, laws, and theories...”<sup>13</sup> Though overall student performance was not impacted on the multiple-choice assessment, it is important to note the gains made in the open-ended and performance tasks occurred while still maintaining achievement on multiple-choice. Among subgroups like those same elementary ELL students, however, statistically significant and educationally meaningful gains were once again evident (Figure 5).<sup>14</sup>

Fig. 4 **NM Elementary – PASS Open-Ended**



“#” indicates educationally meaningful results. ELL comparison group (n=32) and LASER (n=64). Adapted from CREP, “The LASER Model, Summative Report, Section 4” (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 5 **NM Elementary – PASS Multiple Choice**



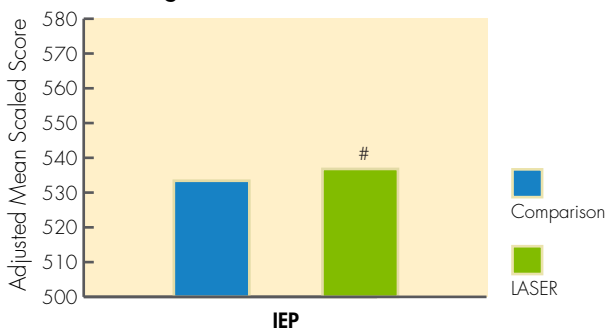
“\*\*” indicates statistically significant results. “#” indicates educationally meaningful results. ELL comparison group (n=37) and LASER (n=71). Adapted from CREP, “The LASER Model, Summative Report, Section 3” (Memphis: CREP / University of Memphis, July 15, 2015).

## What does the New Mexico Standards-Based Assessment tell us about LASER student achievement in reading?

LASER elementary and middle school students also achieved improved test scores as measured by the New Mexico Standards-Based Assessment (SBA) in reading relative to comparison schools.

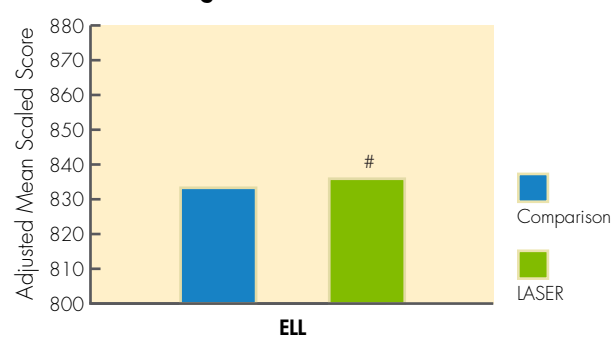
Specifically, elementary IEP students (Figure 6) and middle school ELL students (Figure 7) both demonstrated educationally meaningful gains in their reading scores.<sup>15</sup> Taken together these positive outcomes, seen at grades 5 and 8, in reading as well as science underscore the many benefits of implementing an inquiry science program in accordance with the LASER model. Not only are gains evident across disciplines but across designations including ELLs and those students with IEPs. All told, these are exciting results for the future of the LASER model as a vehicle to prepare all students for educational achievement in STEM (science, technology, engineering, and math), potential career paths, and generally as scientifically literate global citizens.

Fig. 6 **NM Elementary – Standards-Based Assessment in Reading**



"#" indicates educationally meaningful results. Comparison group (n=44) and LASER (n=64). Adapted from CREP, "The LASER Model, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 7 **NM Middle School – Standards-Based Assessment in Reading**



"#" indicates educationally meaningful results. Comparison group (n=32) and LASER (n=23). Adapted from CREP, "The LASER Model, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015).

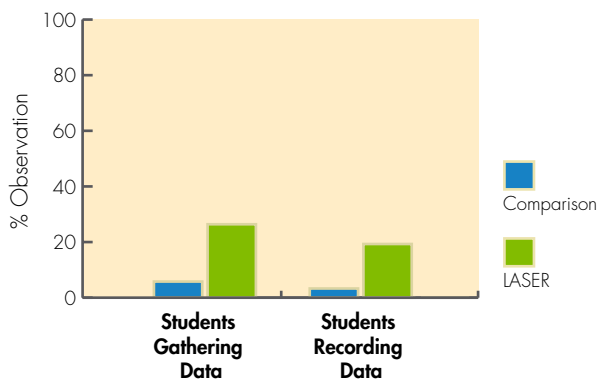
## How did student behavior change as a result of LASER?

Teaching science through inquiry challenges students to ask questions, define problems, carry out investigations, gather and analyze data, and construct explanations. CREP's classroom observations offered insights into LASER i3's impact on students' soft skills, supplementing the data from the PASS performance task.

These results underline the importance of inquiry science as a hook to improve reading and as a hands-on approach to engaging diverse learners.

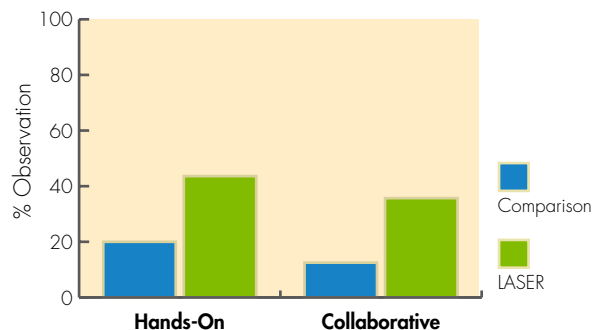
As Figure 8 illustrates, LASER students in NM gathered and recorded evidence more frequently than the comparison group.<sup>16</sup> Evaluators also noted more frequent instances of hands-on and collaborative learning as seen in Figure 9.<sup>17</sup> These opportunities to work as a team to explore questions and solve problems enable students to practice real-life skills needed in the workforce and as they grow into adulthood (Video 2). Furthermore, the observational data collected reaffirm student engagement and enthusiasm for learning science in this manner.<sup>18</sup>

Fig. 8 Classroom Observations – NM



Observational data presented was collected during the 2013-14 school year. Adapted from CREP, "The LASER Model, Summative Report, Section 2" (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 9 Classroom Learning Experiences – NM



Observational data presented was collected during the 2013-14 school year. Adapted from CREP, "The LASER Model, Summative Report, Section 2" (Memphis: CREP / University of Memphis, July 15, 2015).



VIDEO 2:  
Scientists observe, share, collaborate  
<http://bit.ly/scientists-collaborate>



VIDEO 3:  
"The training is fantastic!"  
<http://bit.ly/training-is-fantastic>

## How did teacher practice in NM change as a result of LASER?

Of the 432 New Mexico teachers who began the project, those participating in the LASER group at grades 1–8 received a Science and Technology Concepts (STC™) unit, produced by the SSEC, each year for three years to implement in their classrooms. The research-based, inquiry-centered STC™ curriculum was accompanied by another integral part of the LASER model: high-quality, differentiated professional development (PD). LASER teachers received two levels of PD in each of their three science units. An introductory level training enabled teachers to practice pedagogical strategies with lesson-by-lesson guidance to successfully implement their unit. Intermediate level training took place roughly one year after each introductory training and offered a deeper dive into the science content with investigations geared towards adult learners as described in Video 3.

LASER teachers found these ongoing PD opportunities useful in improving their own knowledge and skills as well as preparing them to implement the curriculum. In 2014, evaluators surveyed teachers regarding their comfort with inquiry-based science instruction. Of NM LASER teachers receiving the SSEC's PD, 71% said they felt





NM LASER teachers attending a PD workshop in the STCTM unit *Rocks and Minerals* examine their materials.

Fig. 11 **Five elements of the LASER model**



“well prepared” or “very well prepared” to teach science using inquiry-based methodologies. Only 26.8% of teachers in the comparison group who received PD as usual reported that same level of self-confidence.<sup>19</sup>

## How did regional partnerships support this effort?

One of the foremost aspects of the SSEC’s work, which differentiates it from other systemic reform efforts, is the LASER model’s inclusion of community and administrative support. The SSEC worked closely with regional partners from the project’s outset to better understand the concerns of each locality and contextualize its programming accordingly. In New Mexico, staff at the Los Alamos National Laboratory Foundation (LANL Foundation) offered their insights and expertise as the regional partner.

With their invaluable input, the SSEC was able to identify key stakeholders to engage in supporting efforts to transform science education. After the LASER i3 project’s launch, school and district-level administrators, teacher leaders, government officials, parents, community organizations, and local businesses were invited to building awareness events designed to share information about LASER i3 and demonstrate the importance of inquiry science, thereby garnering support for the initiative.

Once LASER implementation was underway, leadership teams representing a cross-section of each participating school or district gathered for Strategic Planning Institutes. These weeklong experiences, based on research and best practice, guided teams through developing a five-year strategic plan centered on their shared vision for science and addressing the five elements of the LASER model (see Figure 11).

After attending a Strategic Planning Institute, many leadership teams returned to their communities and discovered specific aspects of implementing their strategic plans to be particularly challenging. The SSEC offered “Implementation Institutes” to reconvene leadership teams with additional support for those specific topics and extra time dedicated to updating and revising their plans.

This responsive, tiered leadership development structure kept LASER i3 participants focused on owning and sustaining the project beyond the grant period while offering opportunities for leaders at all levels to grow. The regional and community partnerships established through this project were fundamental to building local capacity in this way.

## What challenges are faced by school systems across the nation and how did the SSEC address them in NM?

During its 30-year history, the SSEC has encountered many challenges faced by school systems across the nation. The LASER model’s engagement of community partners and inherent capacity building through the leadership development described earlier enables the SSEC to more nimbly respond to these obstacles.



High teacher and administrator turnover is one reality shared by many schools across the nation. The high turnover in LASER i3 school districts paired with geographically disperse schools posed challenges to the SSEC in providing adequate professional development and to CREP in maintaining its evaluation schedule. This challenge was addressed through regular communication about the project in an effort to maintain and grow buy-in. A regional coordinator employed by the SSEC but based in NM made regular school visits to meet with principals and teachers and address their concerns. The SSEC addressed teacher turnover by expanding its PD offerings to include condensed kit trainings led by experienced LASER teachers. In New Mexico, 40 teachers led these abbreviated trainings to fill in the gaps in implementing an STC™ unit for newly hired teachers or teachers unexpectedly assigned to a different grade.



Good Thinking! The Science of Teaching Science: online, on-demand professional development.

The SSEC also developed a collection of on-demand digital offerings to support ongoing PD. *Quick Tips* videos, for example, offer practical suggestions from experienced teachers in teaching specific STC™ units. An animated series called *Good Thinking!* distills valuable educational research to promote effective classroom practice. Finally, the SSEC supported the establishment of eight Professional Learning Communities (PLCs) within and across LASER i3 schools in NM as a homegrown capacity-building effort.

Finally, language barriers added complexity to the implementation of the LASER model in all study regions. While the hands-on nature of inquiry science is hugely beneficial to language acquisition,<sup>20</sup> teachers and principals expressed a need for Spanish language materials “to help students transition to English.”<sup>21</sup> The SSEC responded by producing and distributing instructional resources in Spanish to support ELL teachers and students including literacy readers, assessments, student guides, and even the science “safety contract” required for students to participate in some STC™ units. The SSEC also provided Spanish translations of communications for parents.



Students explore the concepts of motion and design by constructing a car.

## What is the future of LASER i3?

The LASER i3 study demonstrates that inquiry science improves student achievement not only in science but also in reading and math for students of all abilities at elementary and middle school. Armed with this validation, the SSEC will continue its efforts to transform science education and support the LASER i3 regions as they sustain and scale the great work that has already been done.

In New Mexico, the LANL Foundation carries on the work of transforming science education. Discussions are ongoing to determine how the LANL Foundation and the SSEC can best serve the needs of northern New Mexico students. The foundation’s overall plan is to integrate LASER schools with the Inquiry Science Education Consortium (ISEC) into one inquiry science initiative serving the region. The LANL Foundation has earmarked \$2 million per year to ensure sustainability, and the state



NM LASER teachers attending a PD workshop in the STC™ unit *Land and Water* examine the effects of erosion using a stream table

of New Mexico has pledged \$100,000. The LANL Foundation aims to build a coalition of support for the initiative drawing from multiple funding sources to grow to more districts. In addition, it plans to work with a wider group of leaders to broaden the commitment to inquiry science in New Mexico. To aid in this effort, the LANL Foundation has hired two additional professional development specialists and will continue to support the materials procurement, refurbishment, storage, and shipment services provided by the foundation's Science Resource Center.

We know inquiry science programs supported by the LASER model play a critical role in bolstering student learning in science, reading, and math among all students and especially among English language learners, the economically disadvantaged, and students receiving special education. Students are learning science and loving it, thanks to the legacy of LASER i3 and the LASER model's five elements: a research-based, inquiry-centered curriculum; differentiated professional development; administrative and community support; materials support; and state and local assessments to measure the impact on student learning.

## NOTES

<sup>1</sup> A comparison group design is a study design in which outcomes for a group using an intervention are compared to those for a group not using an intervention, with standards set by the U.S. Department of Education What Works Clearinghouse (WWC). See <http://ies.ed.gov/ncee/wwc/glossary.aspx>.

<sup>2</sup> Participating schools were matched based on demographic and achievement variables and then randomly assigned to intervention and comparison groups. The final sample included 60,000 students, 1,900 teachers, and 140 district administrators and principals from 125 schools in 16 urban, suburban, and rural school districts. Conducting an analysis of school level data would have reduced the ability to detect statistically significant findings due to a lower number of schools. It would also render outcome data unreliable by not factoring in the similarity of the learning environment among students in the same school. Therefore the Hierarchical Linear Modeling (HLM) statistical analysis was employed, which is specifically designed for use with clustered data (e.g., students nested within school). See Marty Alberg, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 1: Executive Summary" (Memphis: The Center for Research in Educational Policy [CREP] / University of Memphis, July 15, 2015), 3.

<sup>3</sup> The statistical analyses included a subsample of students in Grade 3 (elementary cohort) and Grade 6 (middle school cohort) who could be followed over the three years of data collection and have outcome data available. This left 9,000 elementary and middle school cohort students who were eligible to be included in the analyses of achievement outcomes. Due to student and school attrition, there were over 6,000 students remaining in the two cohorts by the third and final year of the study. Statistical analyses were then performed on those students with both baseline and final year data available (e.g. Fall 2011 and Spring 2014 data for the analysis of PASS multiple choice outcomes).

<sup>4</sup> SSEC calculations based on: CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, 2013–2014 SSEC LASER i3 Annual Report" (Memphis: CREP / University of Memphis, September 2014), 18.

<sup>5</sup> Schools in 11 school districts were initially identified and

matched for the RCT. Data from eight school districts (Bernalillo Public Schools, Chama Valley Independent School District, Jemez Valley Public Schools, Los Alamos Public Schools, Mora Independent School District, Pecos Independent School District, Rio Rancho Public Schools, Santa Fe Public Schools) was ultimately used for the purposes of the LASER i3 study. The additional 3 districts (Española Municipal Schools, Peñasco Independent School District, and West Las Vegas Public Schools) comprised comparison schools or non-intact cohorts.

<sup>6</sup> "Statistically significant" is a result that cannot occur randomly but rather is likely to be attributable to a specific cause. Statistical significance in LASER i3 is indicated as  $p \leq 0.05$ . The WWC labels a finding statistically significant if the likelihood that the difference is due to chance is less than five percent ( $p = 0.05$ ). See <http://ies.ed.gov/ncee/wwc/glossary.aspx#letterS>.

<sup>7</sup> "Educationally meaningful," sometimes called "substantively important," communicates that a result is meaningful as measured by an effect size, which is a descriptive statistic that indicates the magnitude of difference or comparisons between two measures that are meaningful in the research design to which they are applied. The effect size is an indicator of the change in the average student outcome that can be expected if that student is given the intervention. This is the WWC standard. Effect size change is measured in standard deviations. See <http://ies.ed.gov/ncee/wwc/glossary.aspx#letterE>. In the case of the LASER i3 study, the WWC standard for effect size, as calculated by Hedge's  $g$ , is  $g \geq 0.25$ .

<sup>8</sup> PASS (Partnership for the Assessment of Standards-Based Science) in LASER i3 consisted of multiple-choice questions, open-ended questions, and hands-on performance tasks that "meet the science assessment requirements of the Elementary and Secondary Education Act." For further explanation of the PASS assessments, see "PASS Science Assessment: Partnership for the Assessment of Standards-Based Science," WestEd, last modified 2015, <http://www.wested.org/service/pass-science-assessment-partnership-for-the-assessment-of-standards-based-science/>.

<sup>9</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 4" (Memphis: CREP / University of

Memphis, July 15, 2015), 6, Table 2.

<sup>10</sup> Ibid., 48, Table 28.

<sup>11</sup> WestEd, "PASS: Frequently Asked Questions and Sample Assessment Questions" (San Francisco: WestEd, 2007), 8.  
[http://www.wested.org/online\\_pubs/pass2007\\_faq\\_4\\_07.pdf](http://www.wested.org/online_pubs/pass2007_faq_4_07.pdf).

<sup>12</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 4" (Memphis: CREP / University of Memphis, July 15, 2015), 42, Table 24.

<sup>13</sup> WestEd, "PASS: Frequently Asked Questions and Sample Assessment Questions" (San Francisco: WestEd, 2007), 8.  
[http://www.wested.org/online\\_pubs/pass2007\\_faq\\_4\\_07.pdf](http://www.wested.org/online_pubs/pass2007_faq_4_07.pdf).

<sup>14</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 3" (Memphis: CREP / University of Memphis, July 15, 2015), 27, Table 18.

<sup>15</sup> Ibid., Tables 40 and 42.

<sup>16</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 2" (Memphis: CREP / University of Memphis, July 15, 2015), Appendix A, 55.

<sup>17</sup> Ibid., 50-51.

<sup>18</sup> Observational data measured the percent of classrooms in which the behavior was observed "frequently" or "extensively."

<sup>19</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 2" (Memphis: CREP / University of Memphis, July 15, 2015), Appendix A, 57.

<sup>20</sup> As discussed in "English Learners in Science Education." *In Handbook of Research on Science Education*, edited by Sandra K. Abell and Norman G. Lederman, 204-222. New York, New York: Taylor & Francis, 2014.

<sup>21</sup> CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, 2014 Professional Development Analyses, Section 7" (Memphis: CREP / University of Memphis, July 15, 2015), 28-29.