LASER i3

The LASER Model:

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

Regional Highlights:

North Carolina

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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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 North Carolina as well as New Mexico and the Houston Independent School District (HISD).

A North Carolina LASER teacher examines a specimen at professional development training in the STC™ unit *The Life Cycle of Butterflies*.

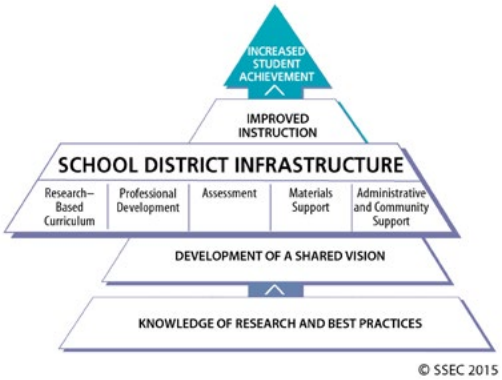
What do we mean by "inquiry"?

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..

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.

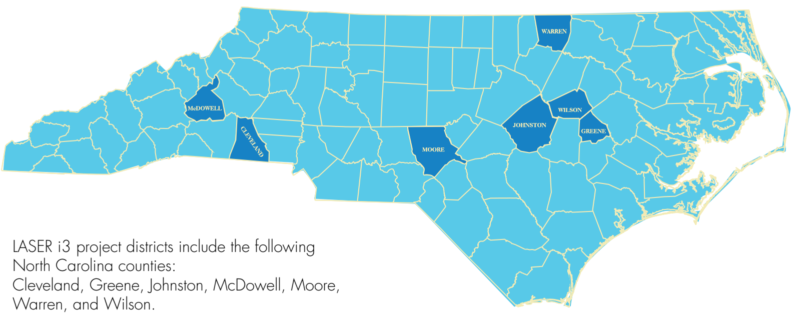
Fig. 1 **SSEC's Theory of Action**



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.

How did the researchers validate LASER?

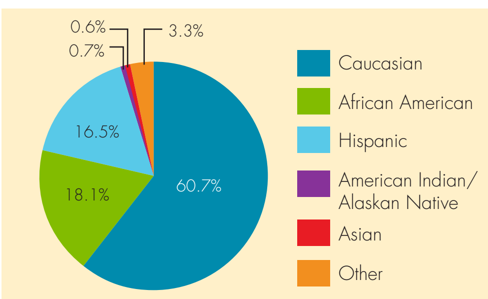
Evaluators from CREP studied approximately 60,000 students attending public elementary and middle schools (urban, rural, and suburban), 35.2% of whom were enrolled in seven school districts across North Carolina. The others attended 50 schools in the HISD and eight school districts in northern New Mexico. CREP employed a matched-pair randomized controlled trial (RCT) using a comparison group design[1] 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.[2]



LASER i3 project districts include the following North Carolina counties:
Cleveland, Greene, Johnston, McDowell, Moore, Warren, and Wilson.

The evaluators began the study with a subsample of more than 9,000 students in elementary and middle school cohorts.[3] 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.

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



Sample size (n) is 21,116. 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.

Why does LASER i3 matter in North Carolina?

The growing diversity of student populations throughout the United States is evident in the demographic makeup of the LASER i3 student sample from North Carolina, which was 60.7% Caucasian, 18.1% African American, 16.5% Hispanic, <1% American Indian/Alaskan Native, and <1% Asian as seen in Figure 2. Of those students, 63.1% qualified as economically disadvantaged, defined by free and reduced price lunch (FRL) participation.[4] Furthermore, of all students study-wide who completed annual assessments, about 18% were English language learners (ELLs) while about 8% had special needs, defined by those children possessing individualized education programs (IEPs).[5]

What were the outcomes of LASER i3?

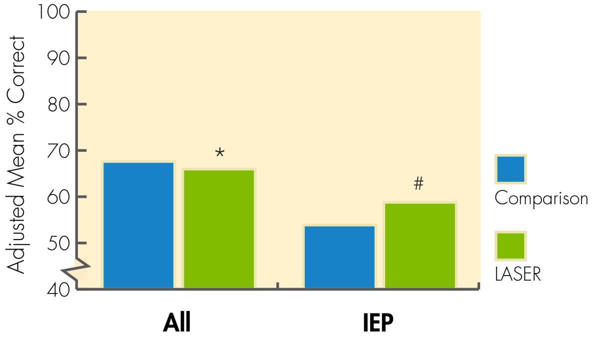
The LASER i3 study resulted in many statistically significant[6] and educationally meaningful[7] improvements in achievement in science as well as in mathematics in North Carolina. "Statistical significance" refers to the likelihood that an outcome can be attributed to a specific cause (i.e., improved 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 in reading, math, and science (Video 1). To compare students across all three regions, schools participating in the study also administered the Partnership for the Assessment of Standards-Based Science (PASS)[8], 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 math, as a result of the implementation of the LASER model transcended classifications of student ability.

VIDEO 1:
Increases in student achievement
http://bit.ly/increase-scores

What does the PASS tell us about North Carolina 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.[9] 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.

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

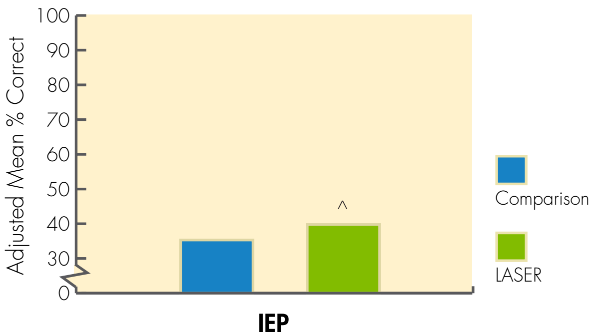


"*" indicates statistically significant results. "#" indicates educationally meaningful results. NC indicates North Carolina. Comparison group sample size (n) is 702 students and LASER sample size (n) is 626 students. IEP students possess individualized education programs. IEP comparison (n=59) and LASER (n=65). Adapted from CREP, "The LASER Model, Summative Report, Section 4" (Memphis: CREP / University of Memphis, July 15, 2015).

In North Carolina, comparison group students started with an advantage in their baseline scores that in some cases, LASER students were unable to overcome by project's end, though they did appear to trend towards closing the gap. When analyzing subgroups, however, elementary special needs students, defined as those with IEPs, demonstrated educationally meaningful gains on the **PASS performance task** (Figure 3).[10]

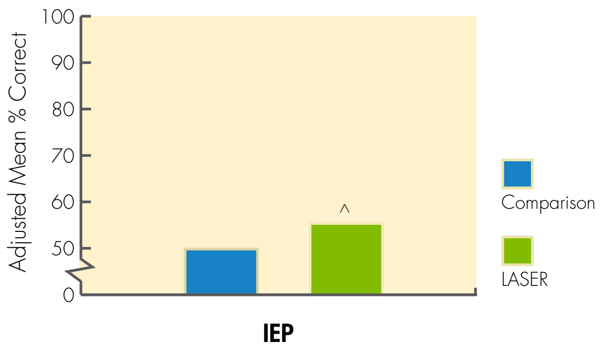
This trend continued into middle school, where IEP students in NC LASER schools, despite the educationally meaningful advantage of comparison students on the pre-test, outperformed their counterparts with nearly educationally meaningful results (Figure 4).[11] This growth is particularly significant given other intervention studies that show effect sizes drop as students progress through school.[12] The **PASS open-ended** assessments required students to "communicate scientific information, inquire, reason scientifically, and use science to express positions in societal issues."[13] Once again, elementary IEP students in North Carolina demonstrated nearly educationally meaningful growth (Figure 5).[14]

Fig. 4 **NC Middle School – PASS Performance Task**



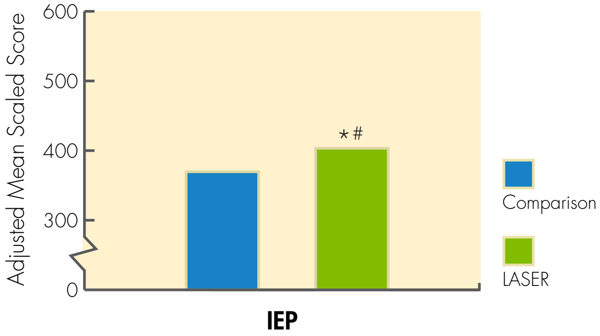
"^" indicates nearly educationally meaningful results as defined by Hedge's *g*=0.23. IEP comparison group (n=46) and LASER (n=43). Adapted from CREP, "The LASER Model, Summative Report, Section 4" (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 5 **NC Elementary – PASS Open-Ended**



"^" indicates nearly educationally meaningful results as defined by Hedge's *g*=0.24. IEP comparison group (n=59) and LASER (n=64). Adapted from CREP, "The LASER Model, Summative Report, Section 4" (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 6 **NC Elementary – PASS Multiple Choice**



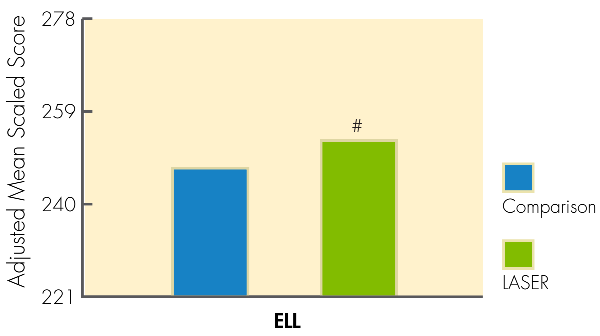
"*" indicates statistically significant results. "#" indicates educationally meaningful results. NC IEP comparison group (n=84) and LASER (n=115). Adapted from CREP, "The LASER Model, Summative Report, Section 3" (Memphis: CREP / University of Memphis, July 15, 2015).

The **PASS multiple-choice** questions assess student "understanding of important scientific facts, concepts, principles, laws, and theories…"[15] In this assessment as well, elementary school students with IEPs showed the greatest growth in North Carolina (Figure 6).[16]

What does the end-of-grade test tell us about LASER student achievement?

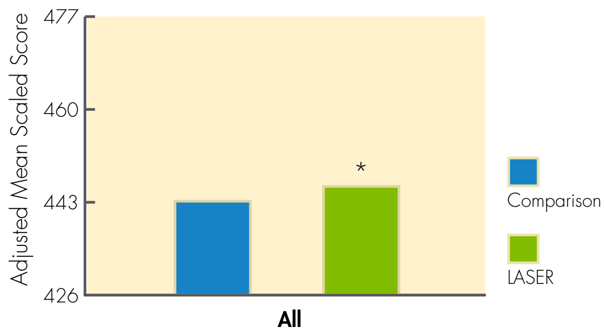
LASER student performance was also assessed against the end-of-grade (EOG) test in North Carolina. Despite the pre-existence of inquiry science in many comparison schools, LASER students still demonstrated gains in achievement. As Figure 7 illustrates, middle school ELL students' scores demonstrated educationally meaningful gains on the EOG assessment in science.[17] Furthermore, all LASER middle school students measured statistically significant improvement on the EOG test in mathematics (Figure 8).[18]

Fig. 7 **NC Middle School – End-of-Grade Test, Science**



"#" indicates educationally meaningful results. Comparison group (n=63) and LASER (n=53). Adapted from CREP, "The LASER Model, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015).

Fig. 8 **NC Middle School – End-of-Grade Test, Mathematics**



"*" indicates statistically significant results. Comparison group (n=888) and LASER (n=522). Adapted from CREP, "The LASER Model, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015).

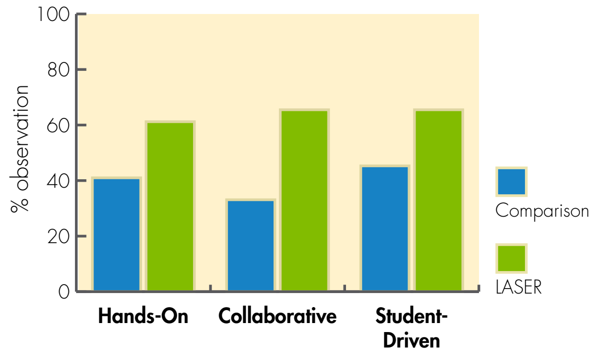
These positive outcomes in math as well as science underscore the benefits of implementing an inquiry science program in accordance with the LASER model. While a number of outcomes favored comparison schools, of which many schools had pre-existing inquiry science programs, LASER students often overcame the deficit, resulting in significant or meaningful gains in some cases. Not only are those gains seen across disciplines but across designations, most notably those students with special needs and English language learners. 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.

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.

As Figure 9 illustrates, evaluators noted more frequent instances of hands-on, collaborative, and student-driven learning in NC LASER classrooms compared to their counterparts.[19] 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 as explained in Video 2. Furthermore, the observational data collected reaffirm student engagement and enthusiasm for learning science in this manner.[20]

Fig. 9 **Classroom Learning Experiences – NC**



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:
Working in groups
http://bit.ly/group-work

VIDEO 3:
"The staff love the PD"
http://bit.ly/love-PD

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

Of the 704 North Carolina 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 instruction. Of NC LASER teachers receiving the SSEC's PD, 55.7% said they felt "well prepared" or "very well prepared" to teach science using inquiry-based methodologies. Only 31.3% of teachers in the comparison group who received PD as usual reported that same level of self-confidence.[21] In that same survey, 59% of NC LASER teachers indicated that their professional development was "very useful" as compared to 8.4% of teachers attending PD provided by their districts.[22]

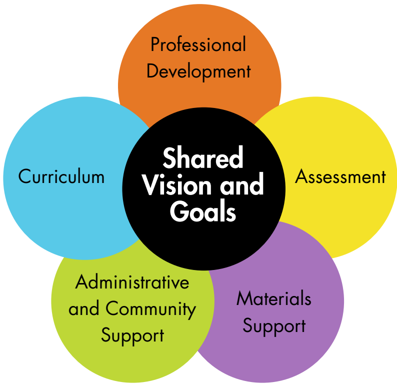
How did regional partnerships support this effort?

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

A North Carolina LASER teacher examines convection tubes at professional development training in the STC™ unit *Understanding Weather and Climate*.

VIDEO 4:
Preparing young minds
http://bit.ly/prepare-minds

Fig. 10 **Five elements of the LASER model**



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 North Carolina, the North Carolina Science, Mathematics, and Technology Education Center (SMT Center) offered their insights and expertise as the regional partner. The SMT Center created a firm foundation for implementation of LASER i3 in North Carolina with their pre-existing relationships across the state and long-standing commitment to inquiry science as seen in Video 4.

The SMT Center was able to identify key stakeholders from its network 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. By project's end, 80% of LASER principals reported their support for inquiry-based instruction thanks to the SMT Center's tireless efforts. [23]

Once LASER implementation was underway, leadership teams representing a cross-section of each participating school 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 10). Owing to the commitment to science education fostered by the SMT Center among district leadership, these teams often included a superintendent or assistant superintendent along with invested community members and teacher leaders. This robust structure empowered teams to plan strategically and commit to actionable items for long-term sustainability and scaling of their science programs.

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 as well as integrating new leadership.

In North Carolina a number of teachers took on advocacy roles in support of inquiry science. Teachers were called upon to travel throughout the state and the nation to share the strength of the LASER model. Some were tapped by the SSEC to act as advisors at leadership institutes in other regions. Others were invited by the SMT Center to consult with local school boards, strategize with state legislators, or visit local industries to share their insights.

This responsive, tiered leadership development structure kept LASER i3 participants focused on owning and sustaining the project beyond the grant period while offering

North Carolina students plan an experiment to explore electric circuits.

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 NC?

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.

North Carolina LASER teachers attending a PD workshop on the STC™ unit *Land and Water* examine the effects of erosion using a stream table.

Many LASER schools encountered difficulties with aligning the STC™ units they received to state standards. In North Carolina, the SMT Center convened standards alignment workshops to address this issue. Curriculum specialists and LASER teachers worked together to develop supplementary materials, including extension activities, to fill the gaps between the STC™ units and North Carolina Essential Standards. This work was then posted online as a resource for teachers across the state. [24]

High teacher and administrator turnover is another reality shared by many schools across the nation. The high turnover in LASER i3 school districts 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 NC made regular school visits to meet with principals and teachers and address their concerns. With the help of the SMT Center, the regional coordinator and LASER teachers were readily connected with incoming administrators to give presentations or participate on phone conferences explaining the value of the LASER model.

The SSEC addressed teacher turnover by expanding its PD offerings to include condensed kit trainings led by experienced LASER teachers. In North Carolina, 58 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. The SSEC also supported the establishment of 12 Professional Learning Communities (PLCs) within and across LASER i3 schools in NC as a homegrown capacity-building effort.

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

Finally, the SSEC 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.

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 math for North Carolina students of all abilities at elementary and middle school, especially those with IEPs or who are ELL. Armed with this validation, the SSEC will continue its efforts to transform science education and support North Carolina as it sustains and scales the great work that has already been done.

North Carolina students experiment with circuit design through inquiry.

In North Carolina, the long-standing relationship between the SSEC and the SMT Center forms a firm foundation for continued implementation of the LASER model. With the results of the LASER i3 project in hand, the SMT Center, with support from the SSEC, will continue growing its infrastructure for sustainable science education in North Carolina. The SMT Center is well prepared for a post-i3 world thanks, in part, to the sustainability planning done by participating LASER districts at leadership development institutes in North Carolina. They will continue their role in supporting inquiry science with $2.5 million earmarked to grow buy-in of new districts and support plans for two regional materials refurbishment centers. These centers were first conceptualized by LASER leaders forming community partnerships as a result of their attendance at Strategic Planning Institutes.

VIDEO 5:
Inquiry science is the foundation
http://bit.ly/science-is-foundation

The SSEC was also awarded a three-year i3 evaluation extension grant from the U.S. Department of Education in which CREP will follow select North Carolina LASER elementary and middle school students as they move on to middle and high school, measuring post-i3 student outcomes like those described in Video 5. This evaluation extension will allow the SSEC to study factors around maintaining student achievement and whole-scale change. In a region with arguably some of the strongest district- and state-level support for inquiry science, this evaluation extension will better inform how systemic reform efforts impact long-term sustainability and student attitudes about science.

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 in North Carolina 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

[1] 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.

[2] 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.

[3] 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).

[4] 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.

[5] SSEC calculations based on: 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), 6-7.

[6] "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.

[7] "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 $g \geq 0.25$.

[8] 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/.

[9] 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.

[10] Ibid., Table 39.

[11] Ibid., Table 41.

[12] Howard S. Bloom, Carolyn J. Hill, Alison Rebeck Black, Mark W. Lipsey, "Performance Trajectories and Performance Gaps as Achievement Effect-Size Benchmarks for Educational Interventions," MDRC, October 2008, http://www.mdrc.org/sites/default/files/full_473.pdf.

[13] 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.

[14] 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), 62, Table 35.

[15] 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.

[16] 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), 38, Table 26.

[17] CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015), Table 60.

[18] Ibid., Table 58.

[19] Ibid., 50-54.

[20] Observational data measured the percent of classrooms in which the behavior was observed "frequently" or "extensively."

[21] CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015), Appendix A, 57.

[22] CREP, "SSEC LASER i3 Validation Study: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, 2013-2014 Regional Report for North Carolina" (Memphis: CREP / University of Memphis, September 2014), 40.

[23] CREP, "The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education, Summative Report, Section 6" (Memphis: CREP / University of Memphis, July 15, 2015), Appendix C, 63.

[24] To see supplementary units and extension activities, see North Carolina Science, Mathematics, and Technology Education Center, "i3 Curriculum," last modified 2015, http://www.ncsmt.org/teacher-resources/i3-curriculum/.