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The LASER Model: A Systemic and Sustainable Approach for Achieving High Standards in Science Education
Summative Report Section 1: Executive Summary

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Acknowledgments

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Introduction

In August 2010, the Smithsonian Science Education Center (SSEC), a division of the Smithsonian Institution formerly known as the National Science Resources Center, received a grant of more than $25 million from the U.S. Department of Education's Investing in Innovation (i3) program for a five-year study to validate its Leadership Assistance for Science Education Reform (LASER) model in three very diverse regions of the United States: rural North Carolina, northern New Mexico, and the Houston Independent School District (HISD). Matching funds to support the study in the amount of more than $5 million were obtained from partners in the three regions as required by the Department of Education.

The independent third-party research evaluation of this five-year validation study was conducted by the Center for Research in Educational Policy (CREP) with technical assistance from Westat and Abt Associates, who were provided to i3 grantees' evaluation partners by the US Department of Education (USDOE). CREP, a Tennessee Center of Excellence, is a research and evaluation unit based at the College of Education, Health and Human Sciences at the University of Memphis.

Interim evaluation results have been reported to SSEC by CREP in annual formal technical reports as well as more informally through presentations and written materials. This document presents overall findings, conclusions, and recommendations in summary form based on analysis of all years of available quantitative and qualitative data. Supporting materials comprising the complete final report include:

- An overview of implementation findings related to the five pillars of the LASER model:
    - Research-based curriculum
    - Differentiated professional development
    - Administrative and community support
    - Materials support
    - Assessment
- A final technical report containing analyses of achievement data from all regions as well as the results of HLM analyses of data previously reported
- A report of findings from the case studies conducted in 20 of the participating schools

Methodology

The LASER i3 Validation study utilized a matched-pair, randomized controlled trial (RCT) complemented by multiple selected case studies. This design meets the What Works Clearinghouse criteria "without reservations," which is the highest possible rating.

Schools in the three regions with intact elementary (grades 3-5) and middle school (grades 6-8) cohorts were paired and randomly assigned to Phase 1 (immediate implementation) or Phase 2 (delayed implementation). The matched-pair design was utilized to ensure equivalency between groups. Implementation data were collected using surveys, structured observations, interviews, and focus groups. The evaluation team elected to use the WestEd developed Partnership for Standards-based

Science Assessment (PASS) test as the primary measure of student learning. State specific achievement test scores were also analyzed. The study was conducted to answer four primary research questions:

1. Do students in schools that receive the LASER model over three years (i.e., Phase 1 schools) attain higher levels of science achievement than students in schools that do not receive the LASER model (i.e., Phase 2 schools) as measured by:
    a. PASS-Basic (multiple choice questions only)?
    b. PASS-Extended (multiple choice questions plus open-ended and performance tasks)?
    c. State assessments?
2. Do these results vary by subgroup?
3. What factors influence the implementation of the LASER model?
4. What is the impact of participation in the LASER model on student attitudes toward science?

During the course of the study, the issue of joiners and their impact on the collection of baseline data was raised. Since all sixth graders were new to their schools and therefore by definition were considered joiners, all middle school results must be reported at the school level rather than at the student level. Although this decision did not impact the study design, it mandated that our work be divided into two separate studies for reporting purposes: results from the elementary study are reported at the student level while results from the middle school study must be considered at the school level.

Population and Context

The population from which the sample for this study was drawn encompasses three regions (Houston Independent School District, rural North Carolina, and northern New Mexico), and represents a total of 16 school districts. This population of school districts includes more than 325,000 students and 20,000 teachers, and over 150 district and building level instructional leaders, with more than half of students (56.2%) identified as "economically disadvantaged" by the National Center for Educational Statistics (NCES) based on free and reduced lunch status. From this total, schools were nominated for participation in the study, and from that nominated list the study sample was created.

Although these regions, and schools within the regions, are very diverse, commonalities exist across the regions that stem from conversations, trends and initiatives taking place at the national level. These have had varying levels of impact on the teaching of science in elementary and middle schools and therefore on the implementation of the LASER model during the course of this study. Most notable are the national debate around Common Core State Standards and associated testing; the Next Generation Science Standards (final draft released in April 2013); new teacher evaluation models; and identification and implementation of programs for low performing schools.

Within each region, unique conditions also existed during the LASER implementation window that had potential to impact implementation of the model. In North Carolina, a program called Read to Achieve was adopted in July 2012 via a state budget act and became effective during the 2013-2014 school year. With mandated summer reading camps and possible retention imposed on students who did not achieve acceptable reading levels by third grade, more instructional time was devoted to the teaching of reading in the lower grades in many NC schools. In Houston, eleven of the LASER i3 schools were also part of that district's Apollo 20 initiative, with multiple strategies in place to close gaps in achievement and more time devoted to testing than was required in other schools. Implementation in Northern New Mexico was impacted by the geography of the region: remote mountain school locations affected teacher travel to professional development sessions; delivery of materials, particularly live specimens; and access to SSEC's regional support system. Partnership with the Los Alamos National Laboratory (LANL) Foundation provided support for schools in that area.

Baseline data collected from teachers prior to LASER i3 implementation in fall 2011 revealed that most students in all three regions received science instruction from their classroom teachers rather than from a science specialist (reported by more than 90% of teachers in all three regions) and that these teachers did not major in science or science education. (Approximately 10% of respondents from New Mexico and HISD and 8% from North Carolina reported holding majors in science.) Science laboratories were more prevalent in Houston schools than in the other regions, with nearly half (49.8%) of teachers reporting that their students went to labs to receive science instruction compared to 10.5% in North Carolina and 1.5% in New Mexico. Time devoted to the teaching of science was also greater in Houston, with teachers reporting an average of 3.3 hours per week of science instruction compared to slightly under 2 ½ hours in North Carolina and slightly over 2 hours in New Mexico.

When asked at baseline about challenges associated with teaching science in elementary and middle schools, teachers' responses were consistent across all three regions. The greatest challenge (reported as substantial or significant by 70% of NM teachers, 63% of NC teachers, and 59% of HISD teachers) was limited time for science instruction. Limited funds for purchasing equipment and supplies and more emphasis on English/language arts and mathematics than science instruction were also reported challenges in all regions.

Sample

The study sample originally included 139 schools across the three regions. These schools went through a nomination and qualification process, were matched based on several school-level demographic and achievement variables, and then randomly assigned to Phase 1 (immediate implementation) or Phase 2 (delayed implementation). After random assignment, changes in school participation occurred within each region, and the final sample contained 125 study schools within the 16 districts and encompassed approximately 60,000 students, 1,900 teachers, and over 140 district administrators and principals. A subsample of 9,000 students in two cohorts (third and sixth graders in 2011-12) was followed longitudinally over the three years of the study, and a further subset of focal schools was randomly selected to participate in additional components of data collection. Additionally, a small number of schools was identified for participation in case study research based upon factors identified as unique or having potential for impacting program implementation and outcomes. A breakdown of the study schools by region, phase, and focal status as well as a detailed description of selection methodology has been provided in previous annual reports.

HISD is the largest school district in the study. Participating schools generally serve Hispanic and African American populations (63.8% and 28.9%, respectively), with most students (88.1%) identified as eligible for free and reduced lunch.

New Mexico LASER schools in the participating school districts range in size from 26 to 984 students. New Mexico districts serve mostly Hispanic, White, and American Indian/ Alaskan populations (48.0%, 34.8%, and 11.7%, respectively), with over half of students (58.0%) qualifying for free and reduced lunch status.

The sizes of LASER schools in the participating school districts in North Carolina (NC) range from 186 to 930 students. Most of the districts serve primarily White and African American populations (60.7% and 18.1%, respectively), with almost two-thirds of students (63.1%) identified as eligible for free or reduced lunch by the North Carolina Public Schools.

Summary of Key Findings Related to Student Achievement

Although student achievement gains as measured by traditional tests comprise only one component of a successful intervention, it is the single outcome of most interest to many constituencies. To obtain valid achievement outcome data, CREP researchers analyzed scores from only students in the elementary and middle school cohorts for whom PASS scores were available at both data points (baseline and spring 2014). State achievement scores for this same group of students were also analyzed. It is important to note that all schools identified as Phase 1 are considered to be in the "treatment" group regardless of their level of implementation of the LASER model, and that fidelity of implementation varied widely across regions and across schools within regions.

The following table of results reports favorable performance by the treatment group (Phase 1) compared to the delayed treatment/control group (Phase 2) on the three sections of the Partnership for Standards-based Science Assessment (PASS) and on a number of state assessments in reading, math, and/or science. Results are identified as being statistically significant (or unlikely to have occurred by chance) and/or as meeting the What Works Clearinghouse standard for being substantively important or educationally meaningful. Positive results on the PASS or on state tests were sometimes evidenced by overcoming a substantial deficit on the pretest; these results are also included in the table.

PASS Structured Response (Multiple Choice) in Elementary Schools

Subgroup	Region	Statistically Significant	Substantively Important/ Educationally Meaningful	Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest
English Language Learners (ELL)	New Mexico	✓	✓	
Males	New Mexico	✓		
Males	North Carolina	✓		
Students identified as Special Education	North Carolina	✓	✓	

PASS Open Ended in Elementary Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
All Students Combined	All Regions Combined	✓		
All Students Combined	North Carolina			✓
English Language Learners (ELL)	All Regions Combined	✓		
English Language Learners (ELL)	New Mexico		✓	
English Language Learners (ELL)	North Carolina			✓
Females	North Carolina			✓
Students identified as Economically Disadvantaged	All Regions Combined	✓		
Students identified as Economically Disadvantaged	HISD	✓		
Students identified as Special Education	New Mexico			✓
Students identified as Special Education	North Carolina		✓	

PASS Open Ended in Middle Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
Students identified as Special Education	North Carolina			✓

PASS Performance Task in Elementary Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
All Students Combined	All Regions Combined	✓		
All Students Combined	HISD	✓	✓	
All Students Combined	New Mexico	✓		
English Language Learners (ELL)	All Regions Combined	✓	✓	
English Language Learners (ELL)	HISD	✓	✓	
English Language Learners (ELL)	New Mexico	✓	✓	
Females	New Mexico			✓
Males	All Regions Combined	✓		
Males	HISD	✓	✓	
Males	New Mexico	✓	✓	
Students identified as Economically Disadvantaged	All Regions Combined	✓		
Students identified as Economically Disadvantaged	HISD	✓	✓	
Students identified as Special Education	All Regions Combined	✓	✓	
Students identified as Special Education	New Mexico	✓	✓	
Students identified as Special Education	North Carolina		✓	

PASS Performance Task in Middle Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
All Students Combined	All Regions Combined	✓		
English Language Learners (ELL)	North Carolina			✓
English Language Learners (ELL)	All Regions Combined		✓	
Females	All Regions Combined	✓	✓	
Males	All Regions Combined	✓		
Students identified as Economically Disadvantaged	All Regions Combined	✓	✓	
Students identified as Special Education	North Carolina			✓

State Assessments: Fall 2011- Spring 2014: Elementary Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
Females	HISD: STAAR Science	✓		
Students identified as Special Education	HISD: STAAR Science		✓	
Students identified as Special Education	New Mexico: Standards Based Assessment Reading Test		✓	

State Assessments: Fall 2011- Spring 2014: Middle Schools				
Subgroup	**Region**	**Statistically Significant**	**Substantively Important/ Educationally Meaningful**	**Phase 1 group overcame an educationally meaningful Phase 2 advantage on the pretest**
All Students Combined	HISD: Stanford Math	✓	✓	
All Students Combined	HISD: Stanford Reading	✓	✓	
All Students Combined	North Carolina: End-of-grade Math	✓		
English Language Learners (ELL)	New Mexico: Standards Based Assessment Reading		✓	
English Language Learners (ELL)	North Carolina: End-of-grade Math			✓
English Language Learners (ELL)	North Carolina: End-of-grade Science		✓	
English Language Learners (ELL)	HISD: STARR Math		✓	
Females	HISD: Stanford Math	✓	✓	
Females	HISD: Stanford Reading	✓	✓	
Females	North Carolina: End-of-grade Math	✓		
Males	HISD: Stanford Math	✓	✓	
Students identified as Economically Disadvantaged	HISD: Stanford Math	✓	✓	
Students identified as Economically Disadvantaged	HISD: Stanford Reading	✓		
Students identified as Special Education	HISD: Stanford Reading			✓
Students identified as Special Education	HISD: STARR Math		✓	

Important and positive trends are evidenced in outcomes related to characteristics commonly agreed upon as most valued by employers. Both the open-ended and performance task sections of the PASS call upon students to communicate their knowledge in written form. They also engage students in activities associated with critical thinking and problem solving. These twenty-first century skills are associated with college and career readiness; it is therefore noteworthy that these are the areas of achievement in which Phase 1 students excelled. It is also important to note that the underserved populations of economically disadvantaged and special needs students, as well as those for whom English is a second language seem to have benefited from their experiences with LASER, both as reflected in scores on the PASS and standardized tests of reading, mathematics, and science.

Summary of Key Findings Related to Student Attitudes toward Science

Qualitative data gathered through teacher focus groups, administrator interviews, and case studies indicate increased student engagement with and interest in science when kit-based inquiry strategies are used. Anecdotal data describe students looking forward to science activities, not wanting to be pulled out of science class for other services, and discussing science learnings with parents after school. Classroom observations support this finding, with consistently high student engagement levels recorded during times when the classroom components of the LASER model are being employed.

Quantitative data regarding student attitudes toward science were gathered through a brief questionnaire administered at the same time as the PASS multiple choice test. The questionnaire contained demographic items and the following five questions related directly to student attitudes:

1. I like science…(a lot, a little, or not at all)
2. Do you think science will be useful to you when you are older?
3. Would you like to be a scientist when you are older?
4. How often to you talk to your family about what you do in science class?
5. How often do you talk to your friends about what you do in science class?

Results showed few differences between students in Phase 1 and Phase 2 schools. It seems from the qualitative and anecdotal data that students were positively impacted by their experiences with kit-based inquiry science in ways that were not captured by the questionnaire. Perhaps inclusion of these questions with the PASS test was a factor. Additional research on this topic is needed to determine the actual level of impact LASER can have on student attitudes toward science.

Summary of Key Findings Related to Implementation Factors

Factors influencing implementation fidelity were documented primarily through qualitative and observational data. Administrator, teacher, and student attrition are factors that typically impact the sustainability of curricular changes in K-12 schools. In the case of LASER i3, many district and school leaders who committed to the work in 2010 were no longer in place by the end of the grant funded period. Ongoing support for all Phase 1 schools was provided by the Smithsonian Science Education Center for the duration of the grant; however, fidelity of implementation was directly impacted in some cases by changes in school and district leadership and shifts in priorities. Additionally, concerns about Common Core, changes in state tests, new teacher evaluations and Next Generation Science Standards have had variable levels of impact on the commitment of districts and schools to the teaching of science and on teachers' perceptions of their ability to devote the time necessary to implement the LASER curriculum as designed.

High quality professional development (PD) for science teachers is a central component of the LASER model. SSEC provided two levels of summer professional development for all science teachers in Phase 1 schools: Level 1 sessions during the summer preceding the launch of each unit at each grade level to familiarize teachers with basic concepts and introduce the kits, and Level 2 sessions during the summer following the initial kit implementation to provide a "deeper dive" into the content associated with each unit. Condensed kit sessions were created for teachers unable to attend the summer sessions. Ideally, a teacher would be able to attend both Level 1 and Level 2 sessions for all three units provided for a single grade level, building both a strong science knowledge base and increased competence in inquiry learning strategies.

Although devoting a week in the summer to PD was problematic for some, feedback on these sessions was universally positive. In fact, it is SSEC's commitment to thoroughly preparing teachers to teach LASER's inquiry-based units that reportedly sets this model apart from other kit-based science initiatives. Teachers who were able to attend all planned professional development sessions for a single grade level reported increased confidence, competence, and enthusiasm for teaching science using kits and inquiry strategies. However, due to attrition, only approximately 25% of teachers attending one session actually attended all three years. Additionally, one-fourth of that group changed grade levels during the implementation period. Teachers' ability to take full advantage of the professional development opportunities offered had a direct impact on their capacity to implement the model in classrooms.

LASER i3 was funded as a randomized control trial with standards set by the What Works Clearinghouse. Because of the need to maintain the sample size, level of implementation did not impact continued participation in the project and continued receipt of materials and other benefits. In addition, there was limited school- and regional-level ability to select units within grade level bands that were perceived to match differing standards and curriculum. Also, the study mandated a progression of unit implementation, with the expectation that three would be implemented at each grade level in the third year, leading to program fatigue in some schools and districts.

Conclusions

Important and positive trends were found in achievement outcomes and in characteristics related to college and career readiness and commonly agreed upon as most valued by employers, as well as those directly related to science. These include written communication, critical thinking, and problem solving - skills that are essential to national competiveness going forward. This positive outcome should not be overlooked. It is also especially important to note that the underserved populations of economically disadvantaged and special needs students, as well as those for whom English is a second language, derived benefit from their experiences with LASER.

Qualitative data gathered through teacher focus groups, administrator interviews, and case studies indicate increased student engagement with and interest in science when kit-based inquiry strategies are used. Observers saw much more experiential hands-on learning and cooperative/collaborative learning in classrooms that had access to the STC Units, and teachers in these classrooms reported greater preparedness to teach students to design and conduct experiments.

In spite of current rhetoric regarding the need for increased emphasis in K-12 schools on all STEM (science, technology, engineering and mathematics) areas, the pressures associated with standardized tests has greatly decreased the time allocated to science teaching and learning in many of our nation's K-12 public schools. Few schools participating in the current study allocated sufficient time at all grade levels to implement the science units as designed, and in some, science was taught only in the grade levels in which it was tested (usually 5^{th} and 8^{th} grades). Still, multiple positive outcomes were achieved, and much has been learned through this study regarding the potential of the LASER model, and particularly the use of inquiry-based strategies in elementary and middle school classrooms, to prepare students for success.

Recommendations

The Smithsonian Science Education Center was limited in its flexibility to alter the LASER project design during the course of this study due to the restrictions of the randomized control trial. The following recommendations for future implementations of LASER have been developed over time and have been discussed with SSEC:

- Given the current educational climate and other priorities, it is difficult for most schools to implement three units with fidelity during school hours in a single academic year. Consider encouraging alternative scheduling, e.g. summer or after-school sessions to expose students to additional units.
- Ensure initial and ongoing school-level commitment to LASER. District support is necessary but not sufficient for successful implementation.
- Ensure that units align with Next Generation Science Standards and make this alignment explicit in marketing materials.
- Consider creating a generic list of standards appropriate to each STC unit so that schools and districts can easily compare those with state standards driving the science curriculum.

- Commit resources to creating Spanish editions of all materials to better meet the needs of ELL populations.
- Include formative assessments for incremental gauging of student understanding of science concepts central to each unit.
- Strengthen and make more obvious the links between science units and ELA/Math skills as well as "non-cognitive" skills such as perseverance, self-regulation, and cooperation.
- Increase the use of technology as a delivery system for teacher professional development as well as a support system for both teachers and students. Consider online or digital videos demonstrating appropriate ways to interact with each unit, possibly packaged as part of the teachers' editions.
- Establish a certification process and database for teacher "experts" who can serve as regional resources.
- Focus resources on schools and districts with clear commitment to high-quality implementation so that outcomes can continue to be documented.